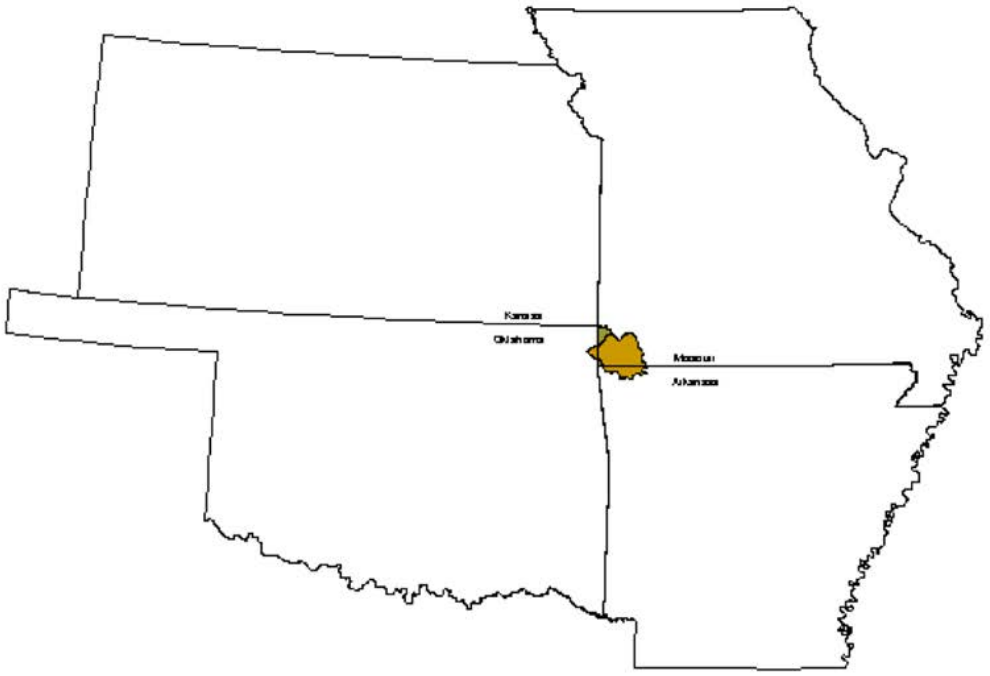

Elk River

Watershed and Inventory Assessment
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Missouri Department of Conservation, Springfield, Missouri
2630 N. Mayfair Springfield, MO 65803

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Executive Summary

The Elk River watershed headwaters originate in Big Sugar Creek near Seligman, Missouri and Little Sugar Creek near Bentonville, Arkansas. These two streams merge near Pineville, Missouri to form the Elk River. Other major tributaries are Indian Creek and Buffalo Creek. Lost Creek and Honey Creek of the Cherokees Lake basin (tributaries of Neosho/Grand River) are included in this watershed assessment. The lower portion of Elk River is inundated by, and forms, the Elk River Arm of Grand Lake O' the Cherokees.

The Elk River basin as covered by this document encompasses an area of 1,032 square miles and the corners of four states, Arkansas, Kansas, Missouri, and Oklahoma. Counties that are partially or entirely within the basin are Benton County, in Arkansas, Crawford County, in Kansas, Barry, McDonald, and Newton counties in Missouri, and Delaware and Ottawa counties in Oklahoma.

The basin is found in the Ozark Plateau physiographic region and further delineated as being entirely within the Springfield Plateau region. Caves, springs, and losing streams are found throughout the basin because of the soluble bedrocks (limestone and dolomite) that underlay the basin. These bedrocks also store large quantities of groundwater. The soils found in the basin are generally shallow, rocky, acidic, and low in fertility. The terrain is rolling and hilly, with localized relief of up to 400 feet.

The streams found in the basin are clear with predominantly chert gravel/cobble streambeds. Average gradient for all streams combined is about 10 feet per mile, but gradients range from less than three feet per mile to over 200 feet per mile. The Elk River is a sixth order stream for its entire length.

The Elk River basin is primarily rural. Land use is about evenly split between forest and pasture/grazing, with smaller amounts distributed among row crop and urban land uses. Animal agriculture is a major enterprise in the basin with McDonald, Newton, and Barry counties consistently ranking in the top five annually, for market value of livestock and poultry products in Missouri. Confined animal agriculture (primarily poultry) has grown explosively in the basin since the early 1980s. Waste management and disposal at these facilities, wastewater treatment and disposal at associated processing plants, and increasing pollutants in basin streams has become a concern in the Elk River basin.

Non-point source pollution in the basin comes from various sources including urban development and runoff, mining, land conversion from forest to pasture, free ranging livestock, channelization, road construction, and septic tanks. Point source pollution sources include sewage treatment plants, poultry processing plants, landfills, industrial discharges, and animal feeding operations.

The Elk River basin is included in the Ozark-Neosho aquatic community division. Streams tend to be very clear with rock and gravel substrates. Fish and other aquatic fauna unique to this area include redspot chub, bluntface shiner, cardinal shiner, southwestern mimic shiner, western slim minnow, Neosho madtom, Arkansas darter, Neosho orangethroat darter, redfin darter, channel darter, yellow mud turtle, Neosho midget crayfish, and Neosho mucket mussel.

Seventy species of fish have been collected from the Elk River basin in Missouri. There are no fish sample records from the time period 1965-1982 for the Elk River basin. Fifty-nine species were collected prior to 1982. Eleven of these species have not been collected since 1965. The channel darter has not been collected since 1946 and is believed to be extirpated in the basin. Sportfish commonly found in basin streams include smallmouth bass, largemouth bass, spotted bass, white and black crappie, rock bass, and channel catfish. Overall, the fish populations appear healthy, but declines in several species are apparent.

A diverse aquatic fauna including mussels, crayfish, and insects is found in the basin. There are several state listed species of concern including: Alabama lip-fern, wooly lip-fern, Ozark chinquapin, marine vine, low prickly pear, Virginia whitlow wort, soapberry, running buffalo clover, Ozark corn salad, chert pebblesnail, elktoe, Neosho mucket, scaleshell, purple lilliput, cave crayfish, bristly cave crayfish, Ozark cavefish, blue sucker, bluntface shiner, plains topminnow, southern brook lamprey, channel darter, ringed salamander, northern crawfish frog, wood frog, eastern collared lizard, great plains skink, yellow mud

turtle, alligator snapping turtle, Texas horned lizard, Cooper's hawk, peregrine falcon, bald eagle, greater prairie-chicken, black-tailed jackrabbit, Indiana bat, and gray bat. The federally listed endangered species are running buffalo clover, peregrine falcon, Indiana bat, and gray bat. The federally threatened species listed for the Elk River basin are Ozark cavefish and bald eagle.

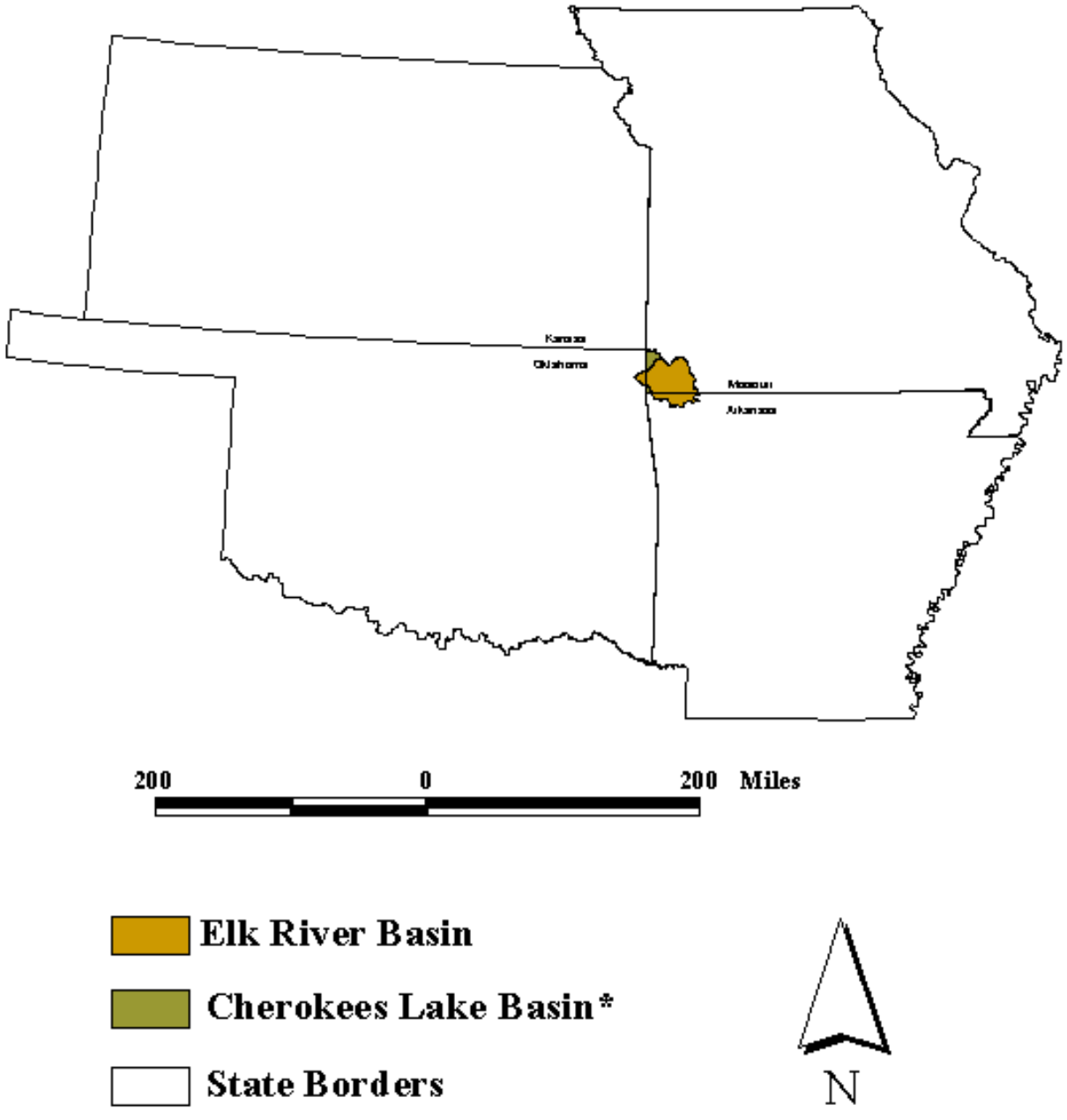
Location

The Elk River watershed (basin) encompasses 1,032 square miles in area (U.S. Environmental Protection Agency website, 1999) of which 866 square miles are in southwest Missouri (MDNR 1985). The basin runs in a westerly direction. It is bound to the east by the James River basin and the White River basin, bound on the north by the Shoal Creek and the Spring River basins (MDNR 1986), and bound on the south and west by the Cherokees Lake basin (U.S. Environmental Protection Agency website, 1999). The Elk River basin is part of the Arkansas-White-Red River basin (MDNR 1986). The largest municipalities which are partially or entirely within the basin are Bentonville (AR), Sulphur Springs (AR), Noel (MO), Anderson (MO), Goodman (MO), and Neosho (MO) (U.S. Environmental Protection Agency website, 1999). Counties that are included in the basin are Benton County in Arkansas, Crawford County in Kansas, Barry, McDonald, and Newton counties in Missouri, and Delaware and Ottawa counties in Oklahoma (U.S. Environmental Protection Agency website, 1999). Population in the Elk River basin in Missouri is about 27,760 (21,100 in Elk River basin, 6,660 in Lost Creek sub-basin) (DuCharme and Miller 1996). The basin is subject to intense water-based recreational use in the warmer months. Intensive animal based agriculture and poor land use are the primary water quality related problems in the watershed.

The Elk River basin takes in the corners of four states, northwest Arkansas, southwest Missouri, southeast Kansas, and northeast Oklahoma (Figure 1). The flow in the basin is westerly. The headwaters originate in several locations including Little Sugar Creek near Rogers, Arkansas, Big Sugar Creek near Seligman, Missouri, and Indian Creek near Fairview, Missouri. Big Sugar Creek and Little Sugar Creek join to form the Elk River near Pineville, Missouri, from which it flows west, terminating in Grand Lake O' the Cherokees in Oklahoma. The Elk River basin, for the purposes of this watershed inventory and assessment, will include two small stream systems (Honey Creek and Lost Creek) that are part of the Cherokees Lake Basin. Figure 2 shows how the Cherokees Lake basin and Elk River basin join. Whenever possible in this document, maps and information for the Elk River basin include Honey Creek and Lost Creek in addition to the streams of the Elk River system. There are only small reaches of these streams in Missouri and the information for the Elk River basin is applicable to them. Portions of Honey Creek, Butler Creek, Little Sugar Creek, and Big Sugar Creek flow into Missouri from Arkansas. Figure 3 demonstrates how the sub-basins are delineated and fit together to form the Elk River basin in Missouri. Figure 4 displays major streams in the Elk River basin. The Elk River basin as outlined drains all of McDonald County (540 sq mi), 38% of Newton County (237 sq. mi.) and 11% of Barry County (89 sq. mi.) in southwest Missouri (MDNR 1986).

There are a number of communities partially or entirely within the Elk River basin (Figure 5). The largest city in the Elk River basin is Bentonville, Arkansas. Neosho is the largest city in the basin in Missouri. Other communities in the Missouri portion of the Elk River basin are Seneca, Stark City, Fairview, Wheaton, Stella, Goodman, Anderson, Lanagan, Pineville, Washburn, Seligman, Noel, and Southwest City. Arkansas communities found in the basin are Sulphur Springs, Bella Vista, Gravette, Pea Ridge, Garfield, Avoca, Little Flock City, Centerton, and the northern edge of Rogers. Several of these communities are only partially within the confines of the Elk River basin. The major roadways found in the Missouri portion of the basin are U.S. Highway 71 and Missouri state highways 43, 59, 76, and 90 (Figure 6). Many other smaller state and county roadways allow access to most parts of the basin.

Figure 1. Elk River basin location.



* - Portions in Missouri included in the Elk River basin plan

Figure 2. USGS eight digit hydrologic units that are used in the Elk River Watershed Inventory and Assessment

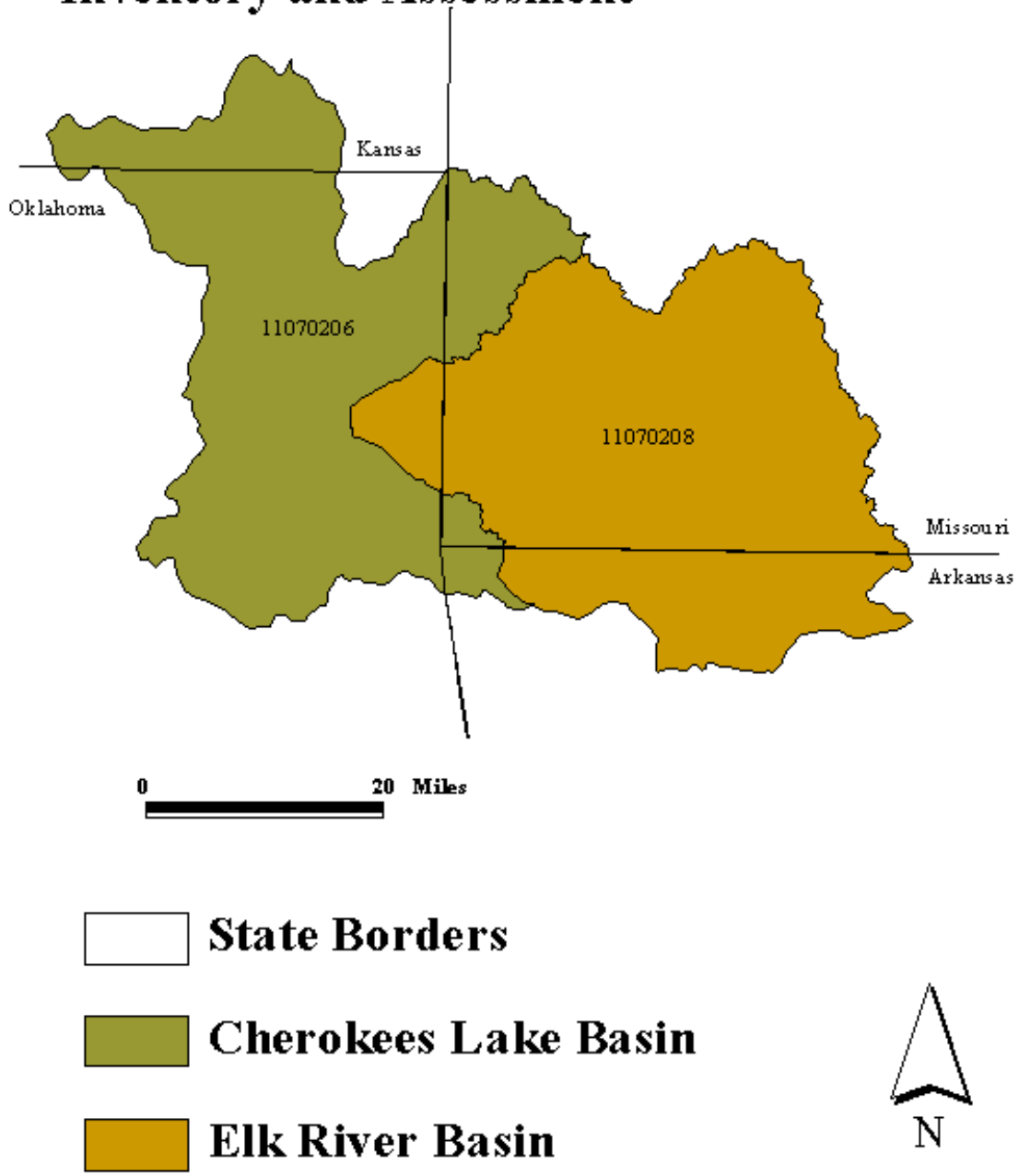


Figure 3. Eleven digit hydrologic units that make up the Elk River basin in Missouri.

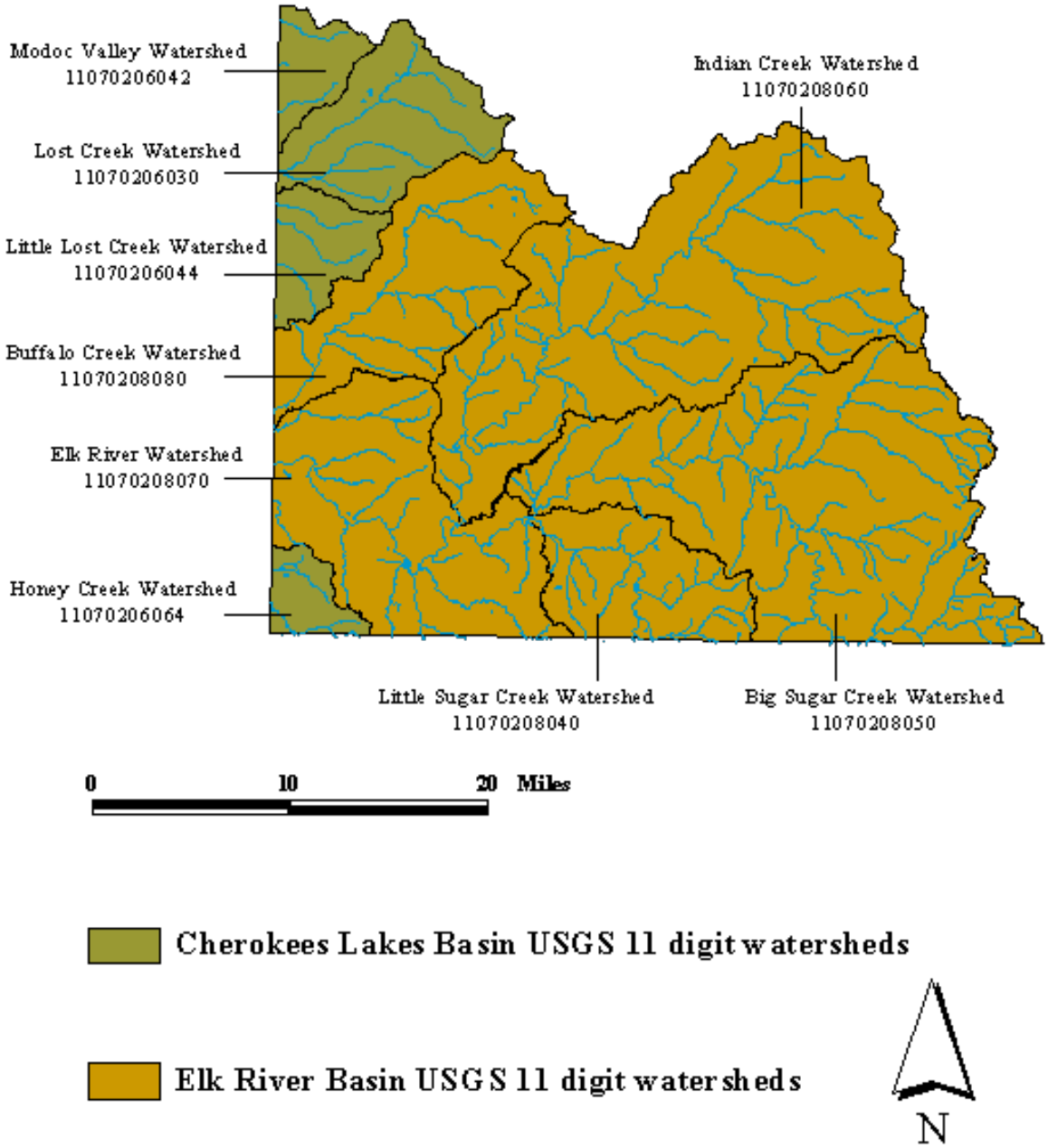


Figure 4. Major Streams in the Elk River basin.

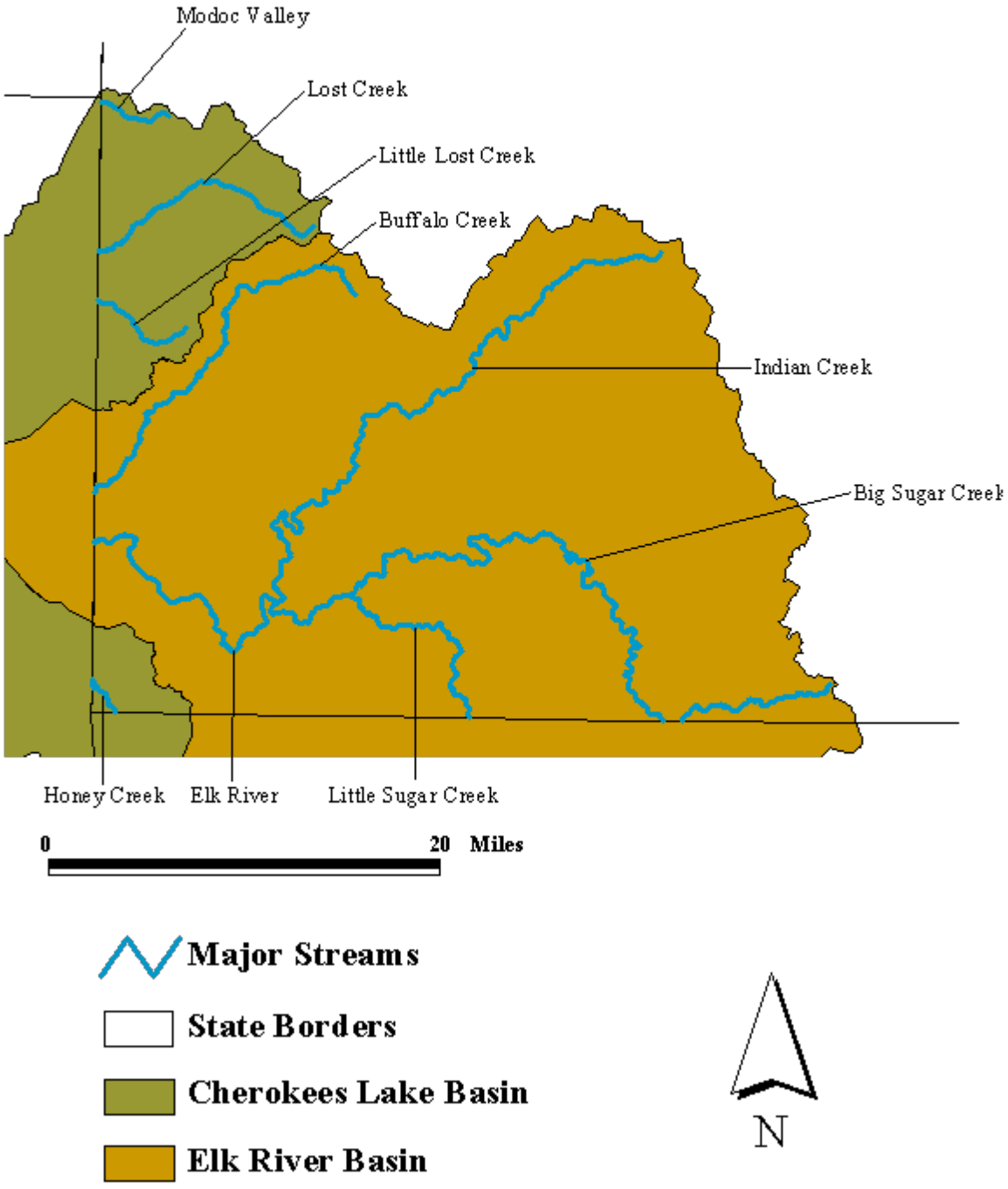


Figure 5. Communities in the Elk River basin.

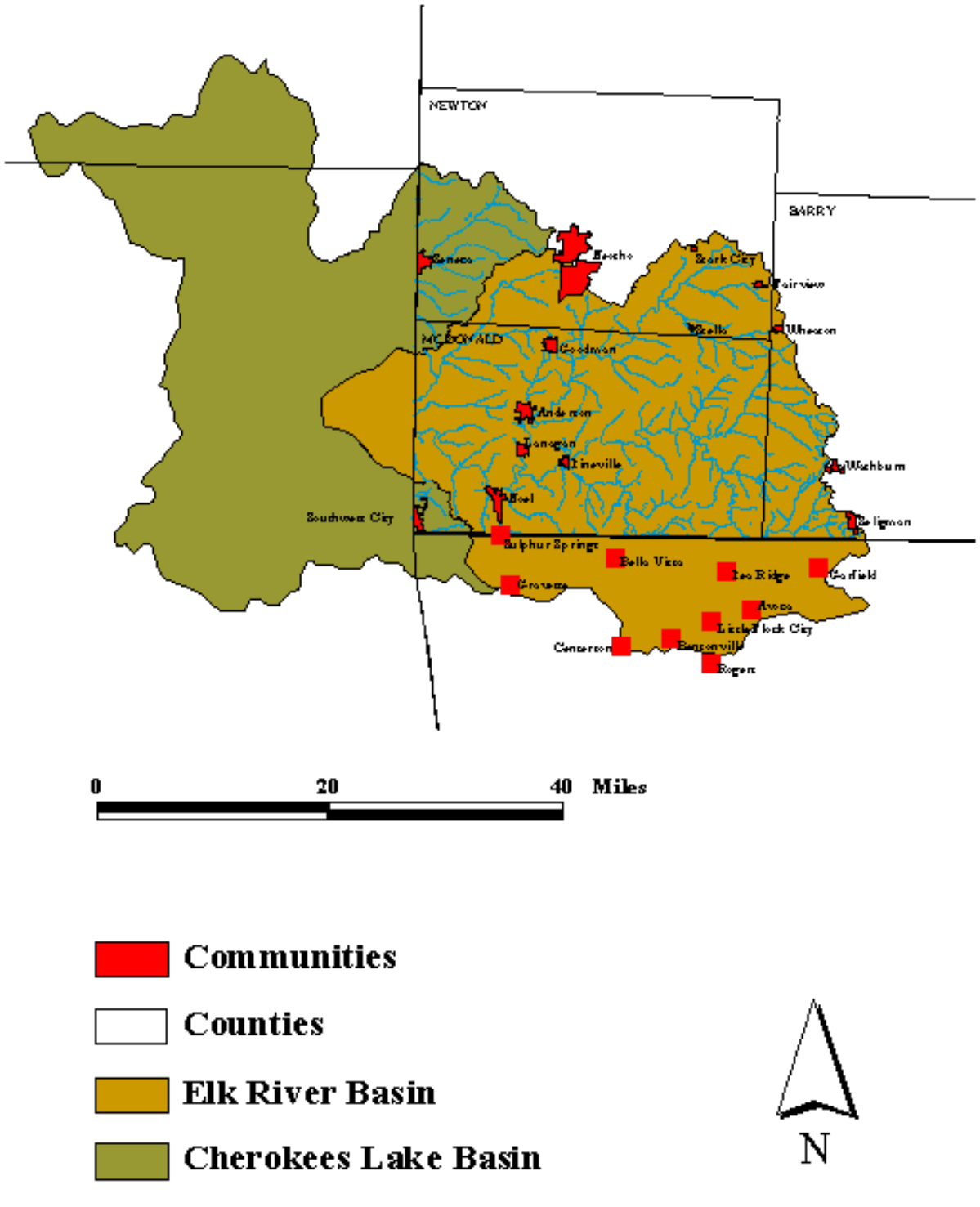
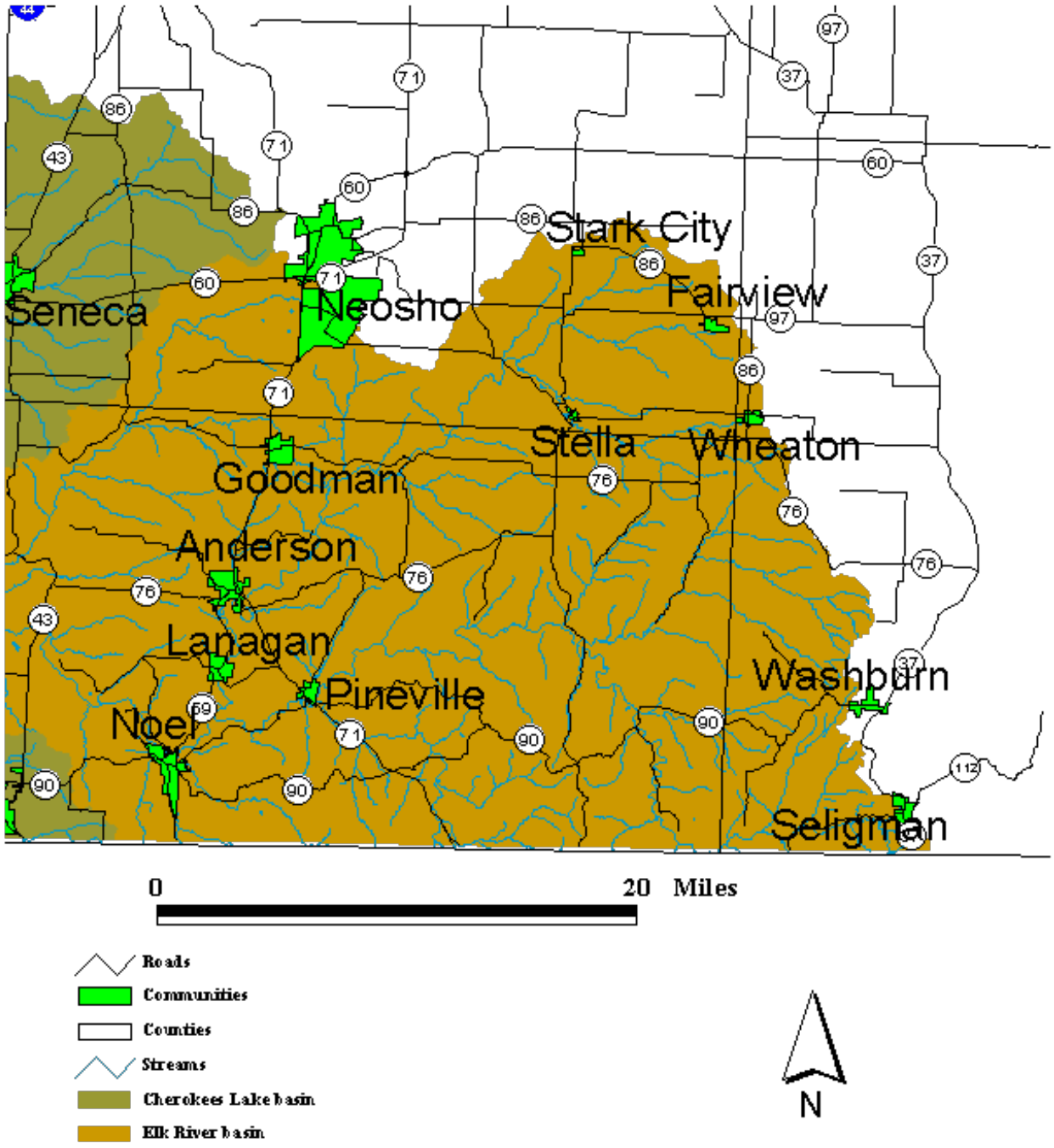


Figure 06.Major highways in the Missouri portion of the Elk River basin.



Geology

Physiographic Region

The Elk River basin lies entirely within the Ozark Plateau physiographic region and is further delineated as being in the Springfield Plateau region (Vandike 1995). Thom and Wilson (1980) included the Elk River basin in the Ozark Plateau natural division of Missouri.

The Springfield Plateau is an area characterized by rolling uplands with elevations ranging from 1,000 to 1,700 feet mean sea level as you proceed from the Oklahoma/Kansas border eastward into Missouri. Karst features occur throughout the Springfield Plateau. Stream dissection provides localized relief of up to 400 feet (MDNR 1986).

Geology and Soils

The bedrock in the basin is primarily Mississippian in origin and consists of limestones, shales, and sandstones (MDNR 1986). The two primary rock types encountered are chert containing limestones and shale. The deepest incised major tributaries cut into shales from the Devonian time period (MDNR 1985). Figure 7 is a general map of the geology in the Elk River basin.

Karst is any terrain based on a layer of soluble bedrock; most often carbonate rocks such as limestones. Karst areas are distributed throughout the basin. Lost Creek and the headwaters area of Buffalo Creek are located in the northernmost karst area in the basin. Another area of karst topography starts around Noel, Missouri and projects south between Otter and Butler creeks. This area continues across the border into Arkansas. A third area of karst geology is found where the confluence of Trent Creek and Big Sugar Creek occurs (MDNR 1986). This presence of Karst topography results in the losing streams, caves, and springs found scattered throughout the basin.

The large area of dolomitic rock beneath the Elk River basin is capable of storing large quantities of groundwater. This groundwater is frequently released to the surface as springs. A large number of springs are found throughout the Elk River basin (Figure 8).

The four soil associations found over the majority of the Elk River basin are Gerald-Creldon-Hoberg-Keeno, Viraton-Wilderness, Nixa-Clarksville, and Gasconade-Opequon-Clarksville. These are a mixture of Ozark and Ozark Border soil types (Allgood and Persinger 1979). Gerald-Creldon-Hoberg-Keeno association soils are "moderately well drained and somewhat poorly drained, loamy and clayey, gently sloping to strongly sloping upland soils that have fragipans." Viraton-Wilderness association soils are "gently sloping, moderately well drained and well drained, loamy, cherty upland soils with fragipans." Nixa-Clarksville association soils are "gently sloping to very steep, moderately well drained to somewhat excessively drained upland soils that have fragipans or cherty subsoils." Gasconade-Opequon-Clarksville association soils are "shallow and deep, gently sloping to steep, loamy and clayey, well drained and somewhat excessively drained upland soils"(Allgood and Persinger 1979). Basically, the soils in the basin tend to be shallow and rocky and most of the terrain is hilly.

Detailed descriptions of county soils are available from the USDA-SCS for Barry and Newton counties. The soil survey for McDonald County is not complete at this time, but is in progress and should be published between 2003 and 2005 (USDA-NRCS, pers. comm.). Soils in the Elk River basin are generally low in fertility and tend to be acidic.

The headwaters of the Elk River basin in Newton County (Lost Creek and Buffalo Creek systems) originate in level uplands that are Gerald-Creldon association soils. They then flow through sloping uplands of Nixa-Tonti and Nixa-Clarksville association soils. Bottom land areas are primarily Huntington-Secesh association soils (USDA-SCS 1989).

The headwaters of the Elk River basin in Barry County are found in two major tributaries. Big Sugar

Creek headwaters originate in the Clarksville-Noark-Nixa soil association and flow into the Hailey-Rock outcrop association. These are moderate to steeply sloping associations in the Ozark highland area.

Indian Creek headwaters originate in Scholten-Tonti association and Hoberg-Creldon-Keeno association soils of the Ozark Border area. (USDA-SCS 1992).

Watershed Area

The Elk River basin encompasses 1,032 square miles of which 866 square miles (84%) are in Missouri (MDNR 1985). Moderate winters with long warm summers are the general climate pattern for the Elk River basin. The prevailing winds are southerly and are strongest in the spring season (MCWC 1974). Temperature extremes range from about -20E F to 110E F with an average yearly temperature of 55E F (MDNR 1976).

Stream Order

The Elk River is a sixth order stream where it originates at the confluence of Big Sugar Creek and Little Sugar Creek. It remains a sixth order stream to its mouth, which is inundated by Grand Lake O' the Cherokees in Oklahoma.

Channel Gradient

Gradients in the Elk River basin average 10.3 feet/mile (Barnett et al 1985). Gradients in headwater reaches of the Elk River basin can exceed 200 feet/mile. Elevation ranges from 1,500 feet above mean sea level (msl) near the headwaters to 680' msl at the mouth (Barnett et al 1985). Grand Lake O' the Cherokees inundates the mouth of the Elk River to a level of 739' msl at normal pool and 756' msl at flood pool. Gradient information for streams and rivers third order and larger in the Elk River basin are available from the MDC's Southwest Regional Office in Springfield, Missouri.

Figure 07.Elk River basin geology.

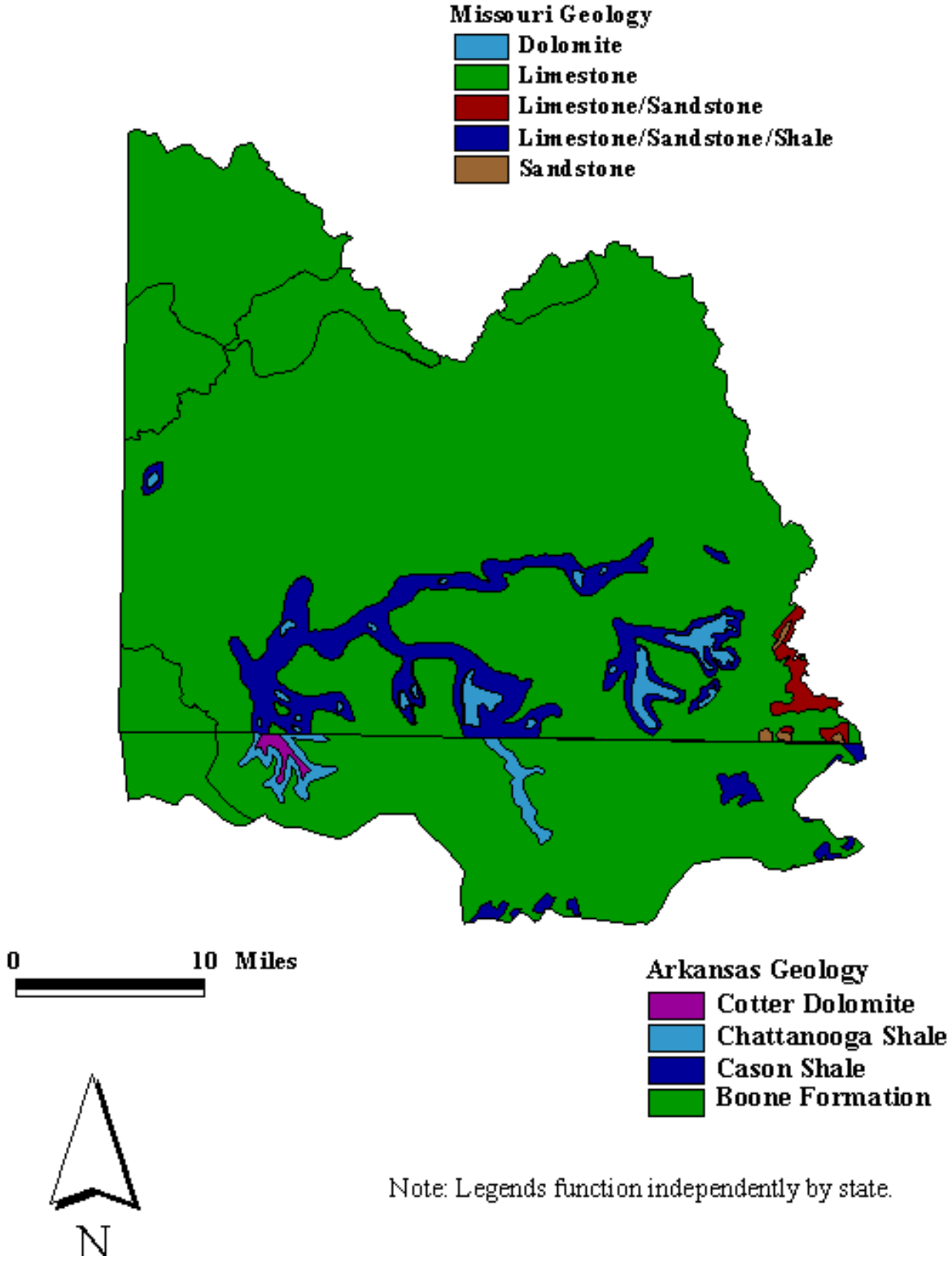
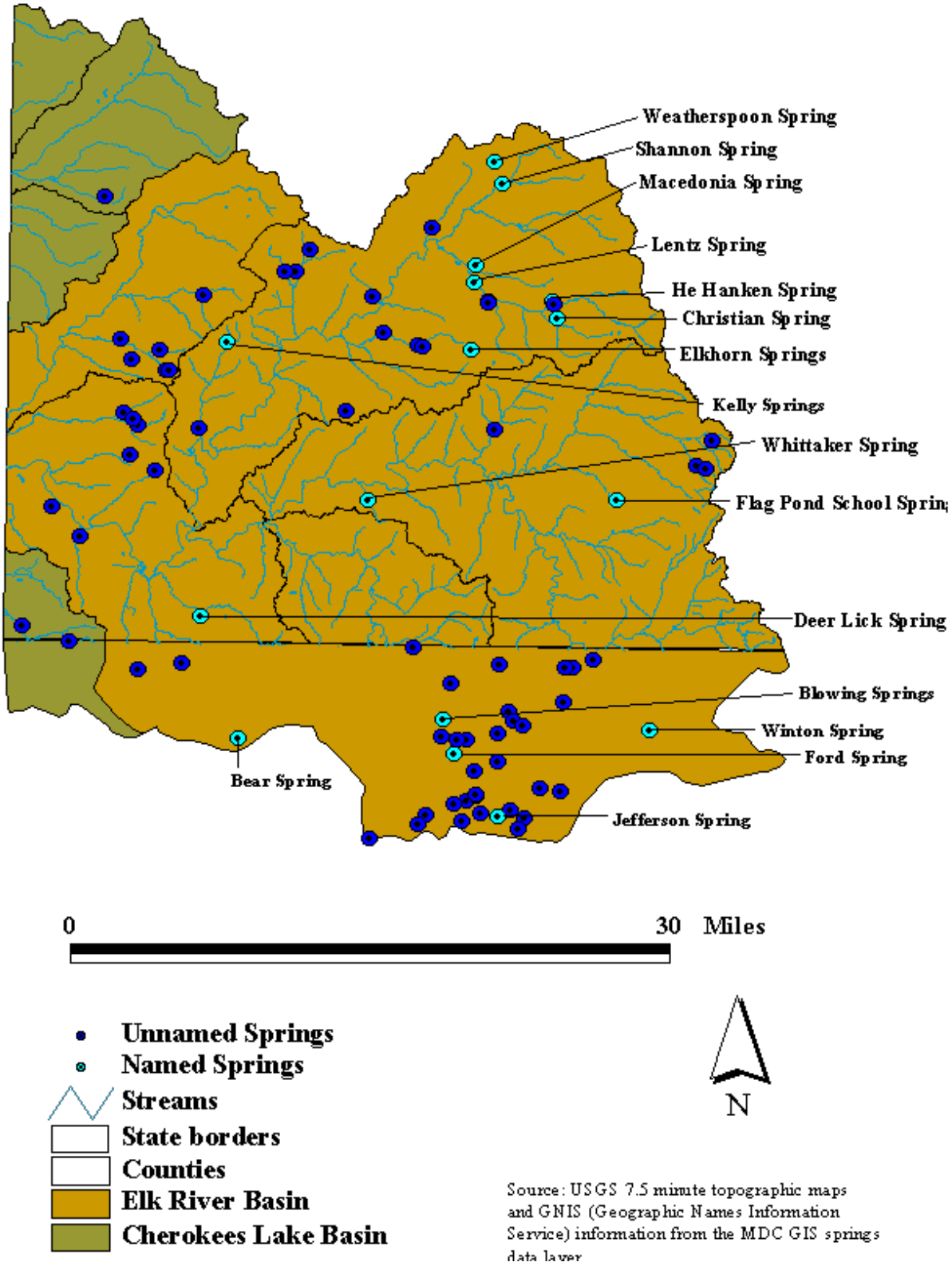


Figure 08.Springs of the Elk River basin.



Land Use

Historic and Recent Land Use

The Ozark highlands are ancient, highly weathered, low plateaus that have been inhabitable for as long as any area in the United States (MDC 1998). In presettlement times Indians roamed the Elk River basin, but never established permanent residence (USDA-SCS 1989). Land cover for the presettlement Elk River basin in Missouri was estimated to be 60 % forest (USDA-SCS 1992) and about 5% prairie (MDC 1998). The remaining area was probably a mixture of intermediate land cover types such as woodlands, glades, and savannas.

The first settlers in Newton County arrived from Arkansas around 1830. Newton County, as originally organized, was about 1,400 square miles in area. It was divided into the present day counties of Newton and McDonald in 1849 (USDA-SCS 1989).

Beginning around 1830 the fertile creek bottoms were cultivated and used to raise crops of wheat, corn, oats, rye, tobacco, and buckwheat. In the early 1900s a fruit growing and truck farming industry developed that replaced grain and livestock farming. A series of droughts in the 1930s ended the fruit and truck farming industry in the area (USDA-SCS 1989). The first dairies were established in the 1870s and are still scattered throughout the area. Raising of beef cattle has long been a stable agricultural enterprise in the area. The poultry industry has developed rapidly since the early 1980s to become a multimillion dollar part of the area's economy. The most frequently cultivated row crops are wheat and soybeans (USDA-SCS 1989). In 1980, only 23% of Newton County was forested.

Mining for lead, zinc, and tripoli became a major industry in the area from 1880 to World War 1 (USDA-SCS 1989). Most of the mining appears to have been concentrated in the northern part of the basin. Mining for tripoli, zinc, and lead were more common historically. Present day mining seems to be primarily limestone products and sand/gravel operations.

The establishment of Camp Crowder military base south of Neosho from 1941 through 1946 and the settling of people exposed to the area while based there caused a steady population increase. This trend continued as people returned to the area upon retirement (USDA-SCS 1989). From 1970-1980 the population of the area increased by about 19%, with Neosho being the fastest growing town in the Missouri portion of the basin (MDNR 1985).

Land use patterns have changed over time in the watershed. Presettlement estimates indicate that 5% or less of the basin was prairie (Schroeder 1982). Information on land use from 1964-1965 indicates that 5% to 10% of the watershed was in cultivation with similar amounts in pasture (MCWC 1974). Land use estimates from 1985 through 1995 indicate that 35% of the watershed was in row crops or pasture, and the remaining 65% was forested (MDNR 1985 and MDNR 1996). George Parsons (MDNR, pers. comm.) indicated that, based on personal observation, considerably more land had been cleared for pasture production and grazing. He estimated the balance between pasture/grazing and forest land uses in 1998 was approaching a 50:50 ratio. The trend over the past 35 years has been conversion of forest to pasture in the Elk River basin. The current (1998) land cover found in the Missouri portion of the Elk River basin is depicted in Figure 9. Three communities in the basin participate in the National Flood Insurance Program (NFIP); Noel, Seneca, and Southwest City. Four communities are located in flood prone areas but are not enrolled in the NFIP; Anderson, Lanagan, Pineville, and Stella (MDNR 1986).

There are three PL 566 projects in the Elk River Basin: Lost Creek, Indian Creek, and Hickory Creek (MDNR 1986). A section 319 project, administered by the Southwest Missouri Resource Conservation and Development Agency, is planned for the Elk River basin. The focus of this project will be the association between water quality and the expanding poultry industry.

Indian Creek is an Environmental Quality Incentives Program (EQIP) priority area (Figure 10; MDC 1998). The EQIP program involves working with landowners to reduce erosion and animal waste

pollution in streams. In the Indian Creek priority area practices are primarily focused on animal waste management. Some of the practices that have been installed in the Indian Creek EQIP area are riparian corridor fencing to exclude livestock from waterways and rotational grazing and/or alternative watering systems to improve vegetative filtering and reduce sediment in runoff reaching streams. Some of the benefits realized by landowners from these programs are streambank stabilization, reduced erosion, improved utilization of pasture, and improved livestock production. Wendal Rogers of the NRCS reported that 4,200 feet of riparian corridor along Indian Creek had been fenced to exclude cattle. He anticipates another 6,000 feet of riparian corridor fencing will be installed along Bullskin Creek in the Indian Creek watershed by 2001. Another landowner has enrolled 11 acres in the Conservation Reserve Program and plans to exclude cattle along this riparian area by installing 2,500 feet of fencing. From July 1998 through June 1999, 15 EQIP contracts were drawn-up involving 1,350 acres and a total financial commitment of $178,622.00. These contracts involved projects dealing with composting facilities, nutrient management plans, planned grazing systems, stack houses, waste utilization practices, and upland wildlife management.

Public Areas

There are a variety of public areas in the Elk River basin ranging from limited access natural areas to river accesses to actively managed conservation areas. The majority of public land areas are owned and/or managed by MDC. Other state and federal agencies with public lands in the basin are the National Park Service (NPS) and MDNR. Several municipalities in the basin manage park areas that provide access to basin streams. Other facilities commonly available at these areas include ball fields, picnic areas, and playgrounds. Table 1 lists the public areas and activities available on them. Figure 11 shows the location of these lands within the Missouri portion of the basin.

Corps of Engineers 404 Jurisdiction

Most instream and some stream-side projects require 404 permits. Applications for permits should be directed to the appropriate U.S. Army Corps of Engineers office. The Elk River basin in Missouri and Arkansas is under the jurisdiction of the Little Rock District, U. S. Army Corps of Engineers (USACOE). In Oklahoma permits are available from the Tulsa District, USACOE.

Tulsa District USACOE

P.O. Box 61

Tulsa OK 74121-0061

(918) 669-7366 or (918) 669-7368

Figure 9. Landcover for the Missouri portion of the Elk River basin.

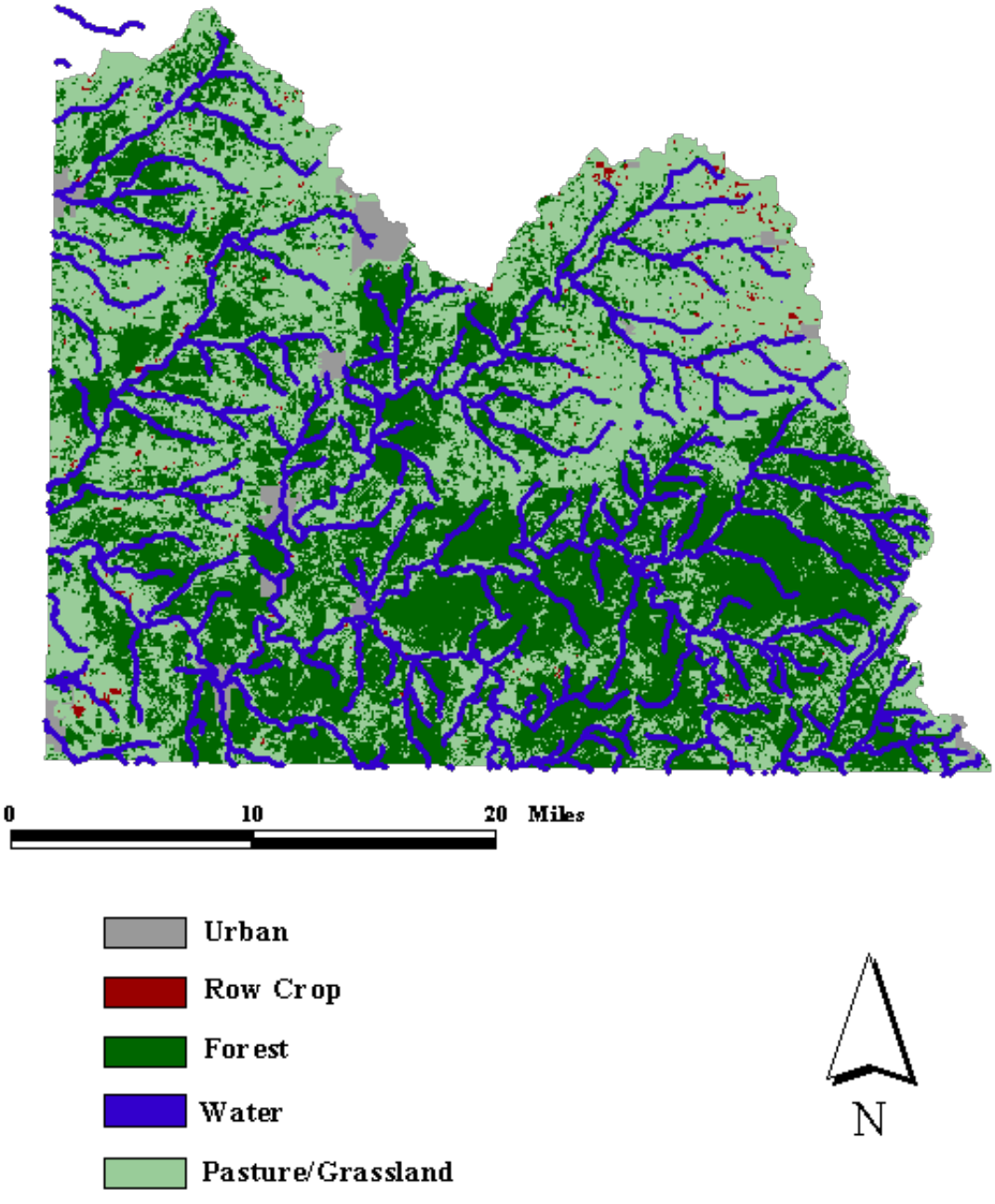


Figure 10. Indian Creek EQIP priority area.

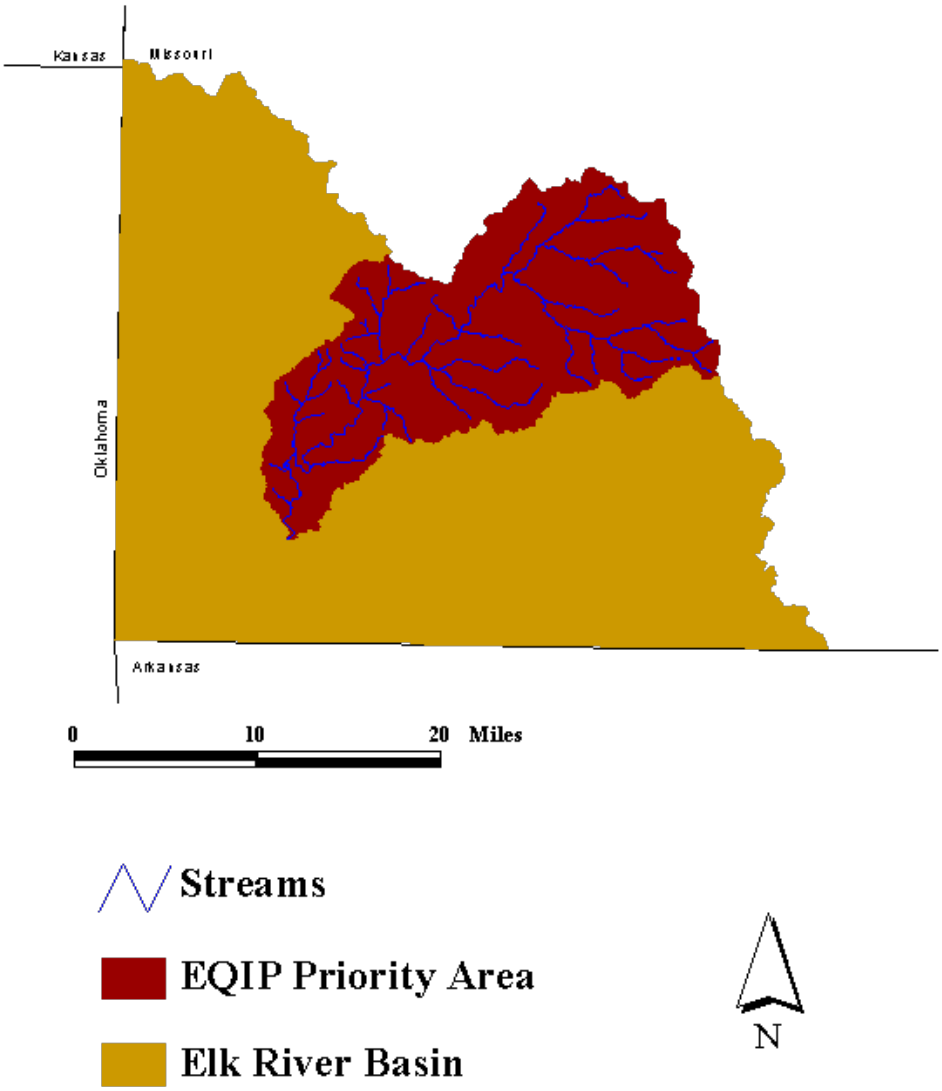
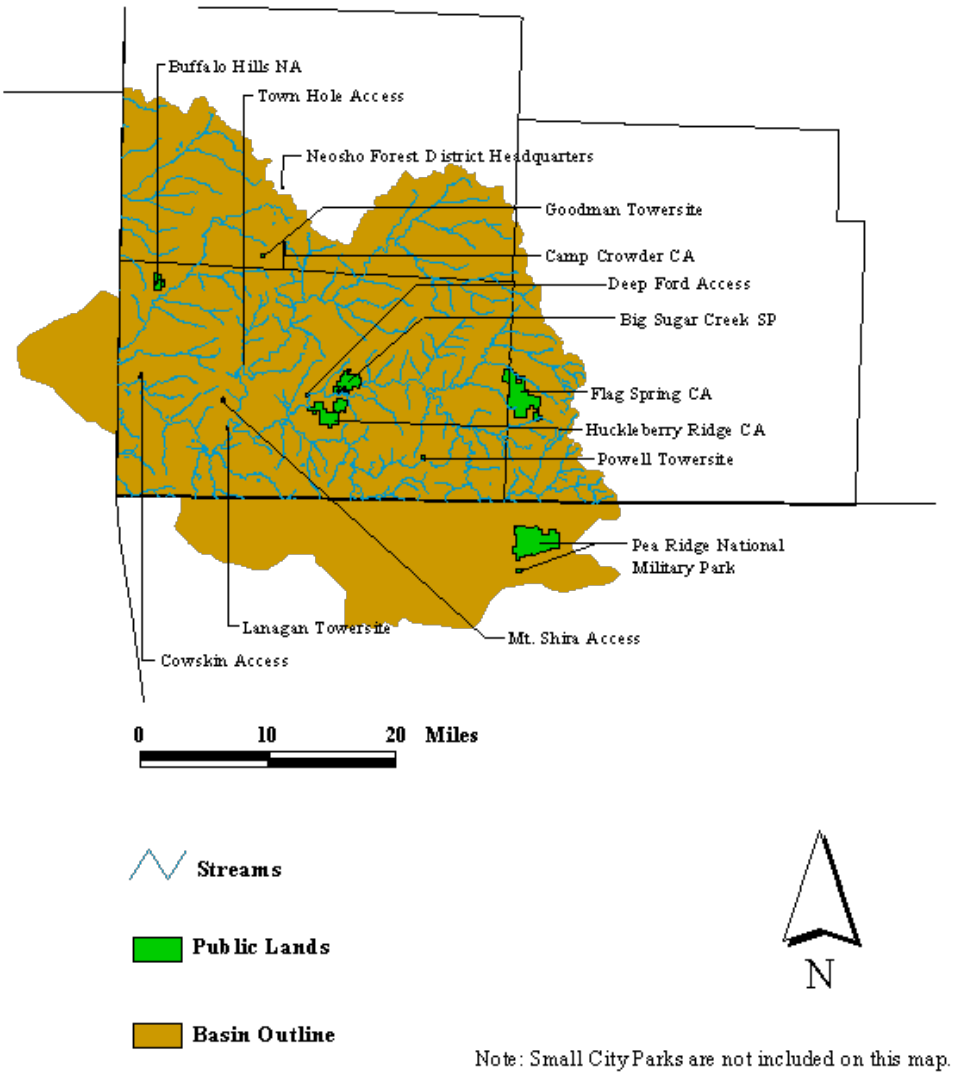


Figure 11. Public lands in the Elk River basin.



Note: Small City Parks are not included on this map.

Table 1. Elk River basin public areas

Area Name	Acres	County	Activities	Management1
Buffalo Hills NA	486	McDonald	Hunting, Hiking, Camping, Bird watching, Nature study, Trapping	MDC
Big Sugar Creek SP	2,048	McDonald	Currently not open. Permitted activities not known.	MDNR
Cowskin Access	41	McDonald	Hunting, Fishing, Hiking, Bird watching, Nature study (0.1 miles Elk River frontage)	MDC
Deep Ford Access	42	McDonald	Hunting, Fishing, Hiking, Bird watching, Nature study (0.25 miles Big Sugar Creek frontage)	MDC
Flag Spring CA	3,955	Barry/ McDonald	Hunting, Hiking, Camping, Bird watching, Nature study, Target shooting	MDC
Fort Crowder CA	2,363	Newton	Hunting, Hiking, Camping, Bird watching, Nature study, Archery, Bicycling, Horseback riding	MDC
Goodman Towersite	40	Newton	Hunting, Hiking, Bird watching, Nature study	MDC
Huckleberry Ridge CA	2,106	McDonald	Hunting, Hiking, Camping, Bird watching, Nature study	MDC
Mt. Shira Access	26	McDonald	Fishing, Camping (0.25 miles Elk river frontage)	MDC
Powell Towersite	80	McDonald	Hunting, Hiking, Bird watching,	MDC

Area Name	Acres	County	Activities	Management1
			Nature Study	
Town Hole Access	2	McDonald	Fishing (Indian Creek frontage)	MDC
Pea Ridge National Military Park	4,300	McDonald	Hiking, Equestrian Trail, Automobile tour	NPS
Lanagan City Park	10	McDonald	Swimming, Fishing, Canoeing, Picnicking, Outdoor recreation (Indian Creek frontage)	Leased by City of Lanagan
Noel City Park	less than 5	McDonald	Swimming, Canoeing, Fishing, Picnicking (Butler Creek frontage)	City of Noel
Sulphur Springs City Park	17	McDonald	Fishing, Camping, Outdoor recreation (Butler Creek frontage)	City of Sulphur Springs
Blankenship Park	16	McDonald	Fishing, Outdoor recreation (Honey Creek frontage)	Southwest City
Memorial Park	50	Benton	Swimming, Outdoor sports, recreation, Picnicking	City of Bentonville
Phillips Park	56	Benton	Outdoor sports recreation, Picnicking	City of Bentonville
Park Springs Park		Benton	Spring, nature trail, Picnicking	City of Bentonville
Neighborhood Parks (3)	varies	Benton	Outdoor recreational activities	City of Bentonville
Dave Peel Park		Benton	Playground, Picnicking	City of Bentonville

[1] Management responsibility - MDC = Missouri Department of Conservation, MDNR = Missouri Department of Natural Resources, NPS = National Park Service

Little Rock District USACOE, P.O. Box 867, Little Rock, AR 72203-0867 (501)324-5295

Hydrology

Precipitation

Precipitation as rainfall averages 41-42" annually, precipitation as snowfall is 12-13" annually, and runoff averages 12" annually (MDNR 1986). The highest runoff is in April-May and the lowest in September, coinciding with seasonal rainfall patterns. Winter snowfall contributes minimally to runoff in the basin, which is primarily rainfall driven (MCWC 1974).

Gauging Stations

The longest running active gauging station in the basin is station 07189000 on the Elk River near Tiff City, Missouri. This gauge records data from a drainage of 872 square miles. It has been in use from October 1939 to present (USGS 1998). Several other gauges have been intermittently used on streams in the basin. Gauge 07188850 on the Elk River at Pineville (1942, 1945, 1947, 1949, 1952, 1962-1965, 1967), gauge 07188870 on Indian Creek at Anderson (1942, 1945, 1947, 1949, 1952, 1962-1965, 1967), gauge 07189100 on Buffalo Creek at Tiff City (1954, 1962-1964, 1967-1975, discontinued partial record station), and gauge 07188500 on Lost Creek at Seneca (1949-1959, 1967-1975; drainage area 42 sq. mi.). Other gauging stations that have been used in the Elk River basin are gauge 07188820 on Little Sugar Creek at Caverna (1967-1975), gauge 07188660 on Mikes Creek at Powell (5/94-5/95), and gauge 07188855 on North Indian Creek near Wanda (5/94-5/95). Groundwater levels were monitored using wells at Longview (1984-1991) and Noel (1984-1991).

Permanent/Intermittent Streams

Funk (1968) listed the Elk River basin as having 169 miles of permanently flowing and 17 miles of intermittently flowing streams with permanent pools in Missouri. The MDNR reported that the Elk River basin in Missouri had 160 miles of classified streams (151 miles of permanently flowing stream, and 9 miles of intermittently flowing streams with permanent pools) (MDNR 1985).

There are 234 third order and larger streams in the Elk River basin with a total stream mileage of 1,115 miles (Table 2). For a more detailed description of stream order, stream mileage, receiving stream, and permanent/intermittent mileage by stream see Appendix A. The permanence/ intermittence of streams usually can be determined from 7.5 minute series topographical maps. Permanent streams are indicated with solid blue lines, and intermittent streams are indicated with dashed blue lines. As of June 1999, several of the topographical maps covering the Elk River basin are only available as provisional editions (draft maps). These provisional maps have all rivers shown as black dashed lines making permanence/intermittence determinations very difficult for many streams. In visiting with personnel of the USGS it was learned that these maps will probably remain provisional maps unless demand increases or some entity comes forward with funding to finish them. Figure 12 displays the topographical maps covering the basin. Losing streams are widespread in the Elk River basin. A losing stream is one where water is "lost," usually into the streambed and becomes groundwater rather than surface water. Losing stream reaches in the Elk River basin are listed in Table 3.

Stream Flow/7-Day Q^2 and Q^{10} Low Flow

On average, in the Missouri portion of the watershed, an area of 5.03 square miles is required to maintain one mile of permanently flowing stream (MDNR 1986). The highest average flows are in April-May, and the lowest are for September, coinciding with the pattern of precipitation which is highest in the spring and lowest in the fall (Figure 13). The highest estimated flow in the Elk River was April 19, 1941, when 137,000 cubic feet per second (cfs) was reported near Tiff City (USGS 1998). The lowest recorded flow at this gauging station (07189000) was 5.1 cfs on September 5, 1954 (USGS 1998). Average flow at this

station is 835 cfs (USGS 1999a). There is concern about reduced flows from Arkansas into the Missouri portion of the watershed. Decreased flows have the potential to negatively affect water quality and aquatic life in the watershed (Lobb 1998).

Low flows for streams in the Elk River basin are listed in Table 4. The 7-day Q^2 is the minimum flow expected for a seven day period that will occur on average once in two years. The 7-day Q^{10} is the minimum flow expected for a seven day period that will occur on average once in ten years. The lowest flows usually occur in the late summer and fall (August, September, and October). Flows tend to be sustained through dry periods by springs and groundwater. Flow duration curves (Figures 14 and 15) indicate the tendency of stream flow to vary over time. Flows are variable for the Elk River basin, but the ready infiltration of surface water into the groundwater system reduces the magnitude of high flows. The corollary discharge of groundwater during dry periods tends to maintain stream flow. This exchange between groundwater and surface water tends to moderate and maintain more "normal" flows in all but extreme conditions.

Dam and Hydropower Influences

There are no major dams in the Missouri portion of the basin. The lower Elk River is inundated in Oklahoma by Grand Lake O' the Cherokees (an impoundment on the Grand [Neosho] River). There are several small to moderate-sized public and private lakes in the basin (Table 5). Due to the soil types and bedrock in the basin, farm ponds are not as numerous as in many other parts of Missouri. Most ponds can be built without permits, and statistics on ponds are usually compiled by county rather than watershed.

These factors complicate the acquisition of accurate, up-to-date information on ponds. Concern exists over the effects ponds have on low-flow conditions as they intercept runoff and allow little or no adjustment for maintenance of stream flows. Gordon (1980) reported three small dams on major tributaries and rivers in the Elk River basin. Indian Creek was impounded at McNatt, Missouri, the Elk River at Noel, Missouri, and Little Sugar Creek at Bella Vista, Arkansas. Based on USGS maps that were photo revised in 1982, there were six new impoundments on tributaries of Little Sugar Creek and one new impoundment on Little Sugar Creek in the Bella Vista area. Flows and water quality in the Little Sugar Creek sub-basin could be altered due to these new impoundments.

Table 2. Number of streams third order and larger and stream mileage by sub-basin for the Elk River basin.

Sub-basin name	Number of streams (>3order)	Total stream miles
Lost Creek *	4	50.3
Buffalo Creek	9	72.4
Indian Creek	68	254.1
Elk River + minor tributaries	29	177.6
Big Sugar Creek	84	340.2
Little Sugar Creek	34	170.1
Honey Creek *	6	50.3
Elk River basin (total)	234	1,115.0

*Grand Lake O'the Cherokees watershed sub-basins included in this document.

Table 3. Losing streams in the Elk River basin in Missouri.

Stream	Receiving Stream	Location T R Sec.		
Little Lost Creek	Lost Creek	25N	33W	25, 26, 27, 28, 36
Second Order Tributary	Little Lost Creek	25N	33W	32, 33, 34
McDougal Branch	Little Lost Creek	24N	33W	8, 17, 18
Buffalo Creek	Elk River	24N	32W	7, 8, 9, 15, 16
Sugar Fork	Buffalo Creek	23N	33W	1, 2, 3
Middle Indian Creek	North Indian Creek	24N	30W	7, 8
Bullskin Creek	Indian Creek	32W	24N	26, 35
Second Order Tributary	Bullskin Creek	24N	32W	26, 23
		24N	30W	11, 12
Middle Indian Creek	North Indian Creek	24N	29W	7
Second Order Tributary	South Indian Creek	24N	29W	31, 32, 33
Second Order Tributary	Middle Indian Creek	24N	29W	7, 8, 9
Second Order Tributary	Beaver Branch	23N	32W	8, 17
Beaver Branch	Indian Creek	23N	32W	30
		23N	32W	36
		23N	32W	1, 12
Unnamed Tributary #28	Bullskin Creek	23N	32W	3, 9
Second Order Tributary	Cave Spring Branch	24N	34W	15, 16, 21
Second Order Tributary	Yarnell Branch	24N	33W	16, 17
Yarnell Branch	Elk River	24N	33W	16, 21, 28
Second Order Tributary	Miser Hollow	21N	31W	16, 21

Table 4. Seven-day Q^2 and 7-day Q^{10} low flows for streams in the Elk River basin.

USGS Station No.	Stream	Period of Record	7-Day Q^2 (cfs)	7-Day Q^{10} (cfs)
07188500	Lost Creek at Seneca	1949-1959	6.6	0.9
07188850	Elk River at Pineville	1942,1945, 1947, 1949, 1952, 1962-1965, 1967	41	8.8
07188870	Indian Creek at Anderson	1942, 1945, 1947, 1949, 1952, 1962-1965, 1967	50	15
07189000	Elk River near Tiff City	1940-1966	88	25
07189100	Buffalo Creek at Tiff City	1954, 1962-1964	7.0	0.0

Source: Skelton (1976).

Second Order Tributary	Missouri Creek	21N	31W	14, 23
Second Order Tributary	Missouri Creek	21N	31W	12, 13
Missouri Creek	Little Sugar Creek	21N	31W	13, 16, 21, 22
		21N	30W	16, 17, 18
Second Order Tributary	Bear Creek	21N	30W	21
Bear Creek	Little Sugar Creek	21N	30W	19, 20, 21, 28, 30
		21N	31W	35, 36
Second Order	Bear Creek	21N	31W	25, 36
Big Sugar Creek	Elk Creek	21N	30W	1, 2
		22N	30W	35

Figure 12. USGS 7.5 minute topographic map coverage for the Elk River basin.

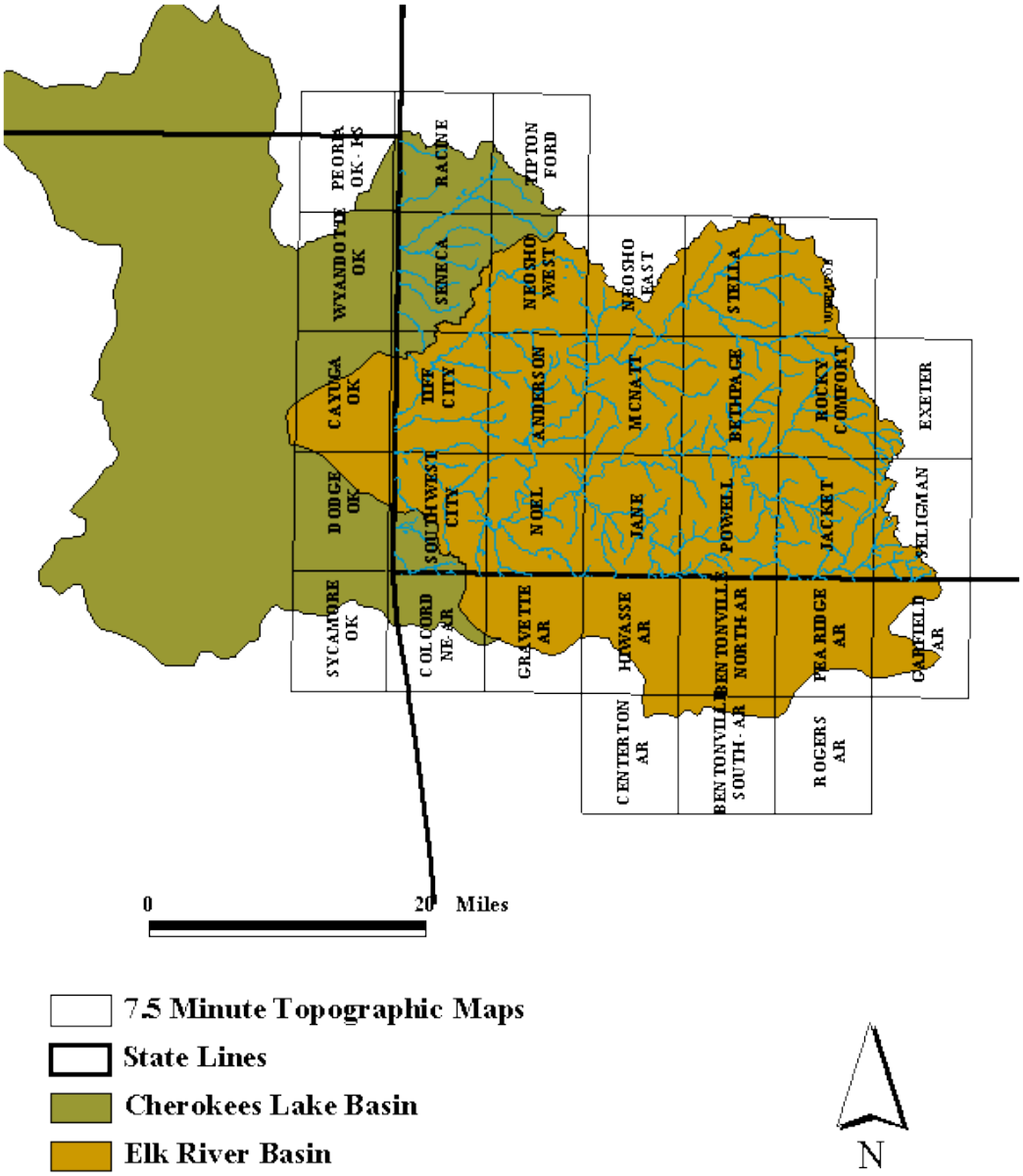
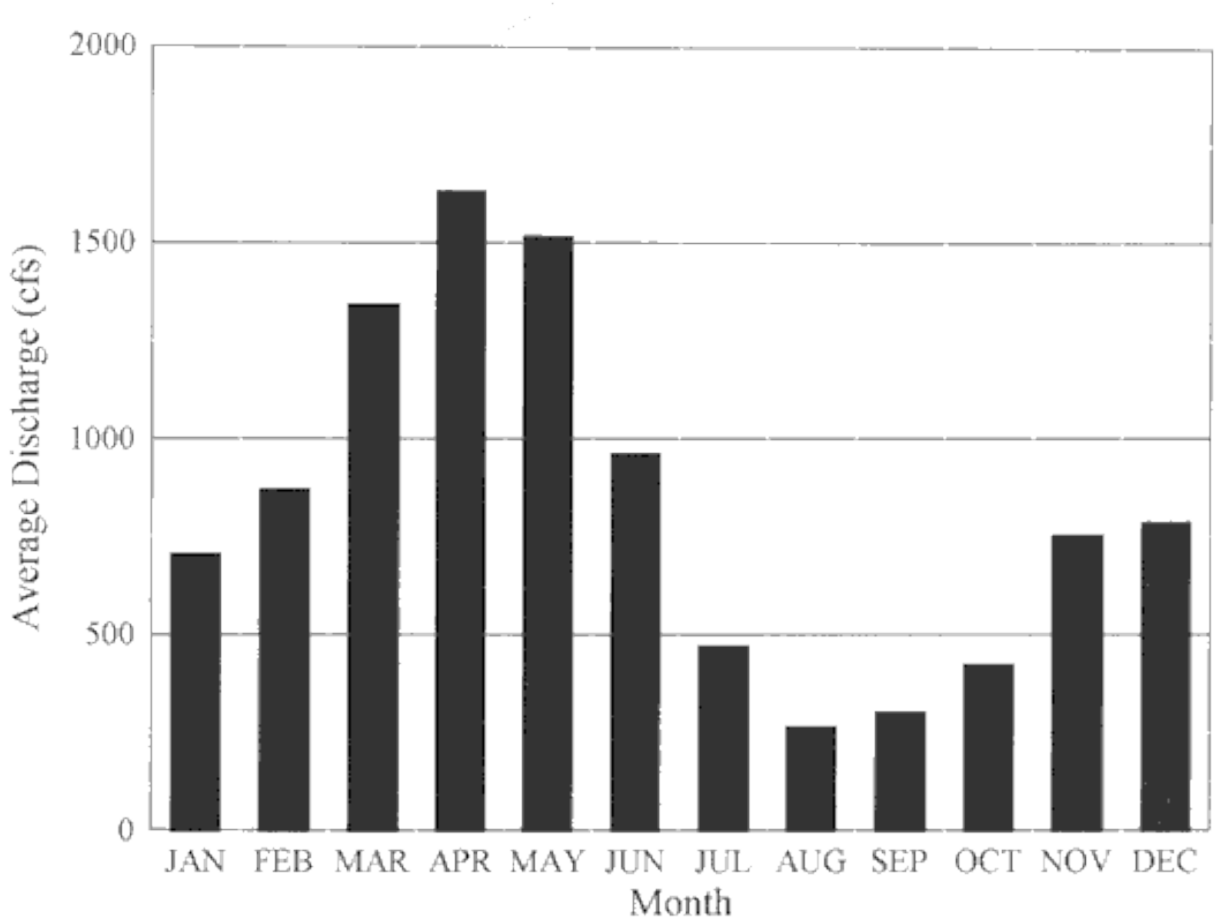


Table 5. Major lakes in the Elk River basin in Missouri and Arkansas.

Location	Lake Name	Stream(s) Impounded	Surface Acres
Bella Vista, AR	Ann	Pinion Hollow (Tributary of Little Sugar Creek)	**112**
Bella Vista, AR	Avalon	Tributary of Tanyard Creek	**67**
Bella Vista, AR	Brittany	Tributary of Pinion Hollow	**35**
Bella Vista, AR	Loch Lomond	Gordon Hollow, Unnamed #104, Unnamed #105	**477**
Bella Vista, AR	Norwood	Tributary of Little Sugar Creek	**35**
Bella Vista, AR	Rayburn	Tributary of Little Sugar Creek	**45**
Bella Vista, AR	Windsor	Tanyard Creek	**220**
Noel, MO	Lake St. Clair	Elk River	**30**
Bella Vista, AR	Bella Vista	Little Sugar Creek	**35**
Southwest City	**Blankenship**	**Honey Creek**	**2**

Figure 13. Average annual discharge for the Elk River basin at gauging station 07189000 near Tiff City, Missouri.



Source: DuCharme and Miller (1996).

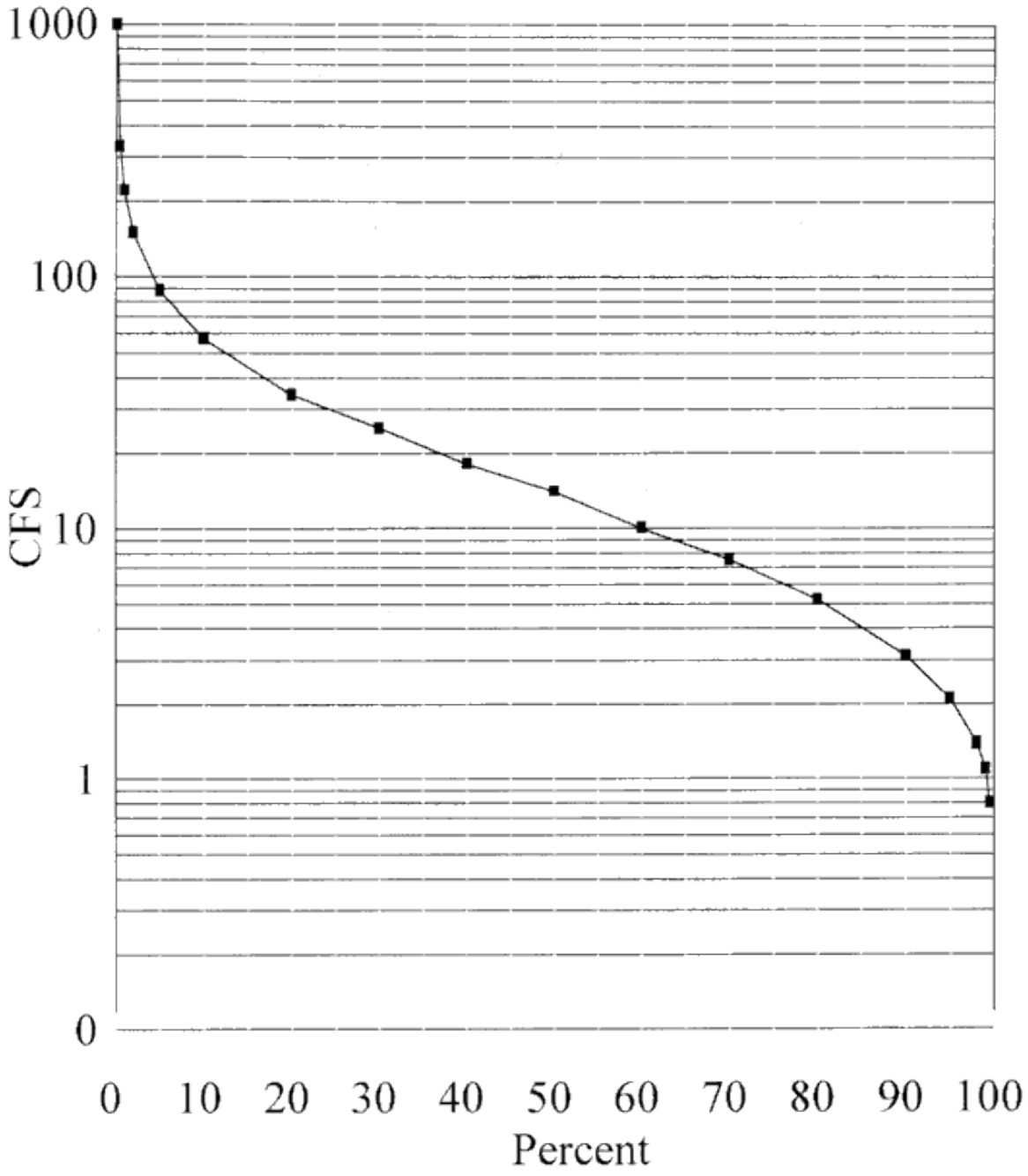
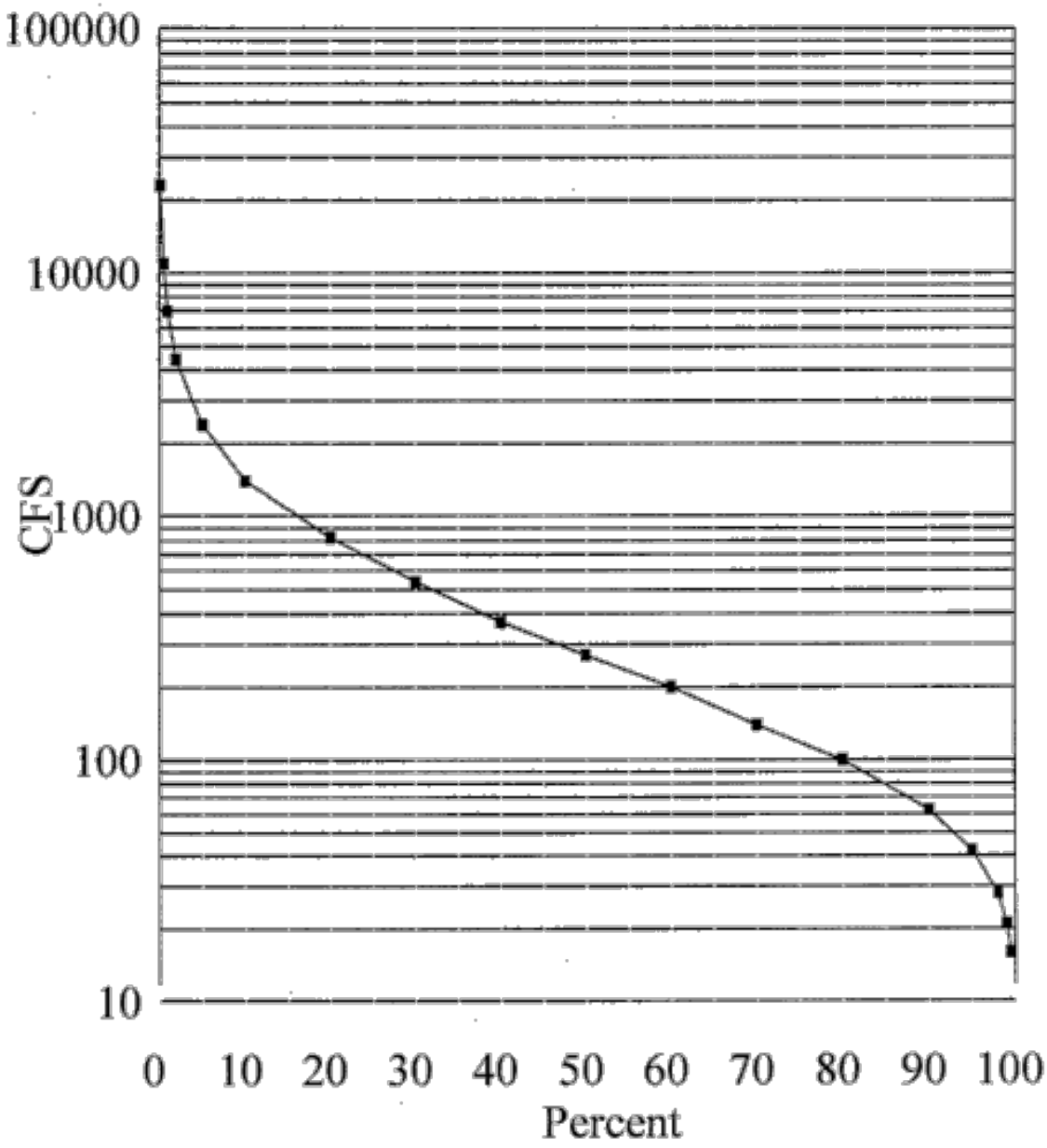


Figure 14.Flow duration curve for Lost Creek at gauging station 07188500 near Seneca, Missouri.

Figure 15. Flow duration curve for Elk River at gauging station 07189000 near Tiff City, Missouri.



Water Quality and Use

Beneficial Use Attainment

All streams in the Elk River basin are classified for aquatic life protection, fishing, and livestock/wildlife watering. The permanent flowing reaches of the Elk River, Buffalo Creek, Indian Creek, Big Sugar Creek, and Lost Creek are also classified for whole body contact recreation and boating. The permanently flowing reaches of South Indian Creek are classified for coldwater sport fishery (MDNR 1985).

Section 303(d) of the Clean Water Act requires states to list waters not expected to meet established, state water quality standards even after application of conventional technology-based controls for which total maximum daily load (TMDL) studies have not yet been completed. The list is produced annually by the MDNR and includes waters for which existing required pollution controls are not stringent enough to maintain state water quality standards. The 1998 MDNR list includes: 35 miles of Big Sugar Creek; 9 miles of Buffalo Creek; 21.5 miles of Elk River; 26 miles of Indian Creek; 10.5 miles of North Indian Creek; 9 miles of South Indian Creek; 11 miles of Little Sugar Creek; and 2 miles of Patterson Creek in the Elk River basin (MDNR 1998b). These streams in the Elk River basin are negatively impacted by nutrients from livestock production and are not expected to meet water quality standards through the implementation of any currently required pollution control technology (MDNR 1998b).

Town Branch, a tributary of Little Sugar Creek that originates in the Bentonville area, was monitored by the Arkansas Department of Pollution Control and Ecology (ADPCE) and was found to be non-supporting for drinking water uses and only partially supporting of aquatic life protection. The pollutants causing the problems were nutrients of municipal point source origin (ADPCE 1996). Little Sugar Creek was evaluated as partially supporting protection of aquatic life primarily due to chronic turbidity and elevated nutrients from agricultural and municipal non-point sources. Other sources of pollutants in the area causing non-support of aquatic life use were pasture used for poultry waste application, instream gravel removal, and road construction (ADPCE 1996).

Chemical Quality of Streams

The overall water quality of streams in the Elk River basin historically has been excellent with isolated pollution incidents causing localized problems, usually of short duration. A basin-wide water quality network was started in 1990 to monitor water quality changes because of concern over the large amounts of animal wastes land applied in the basin. A tremendous increase in the number of confined animal operations in this area resulted in increased application of animal wastes. The trend in water quality in the basin as shown by USGS data (intermittently collected from 1967 through 1993) and Crowder College data (1990-1993) was upward for total nitrogen. It was suspected that bacteria (fecal coliform and/or fecal strep) levels in basin streams may be exceeding state water quality standards during the recreational season and under normal flow conditions.

Water quality investigations are underway to determine the extent of phosphorus contamination, but only preliminary summaries are currently available. In most stream systems phosphorus availability is the factor limiting plant and algae growth. When phosphorus increases, the limiting effect is altered, and excessive plant and algae growth often results. The U. S. Environmental Protection Agency (EPA) suggests that phosphorus should be 0.1 mg/L or less to prevent nuisance plant growth in streams (USGS 1999b). The EPA index of watershed indicators report on ambient water quality monitoring of phosphorus, pH, dissolved oxygen, and ammonia in the Elk River basin found phosphorus exceeding established criteria in 45 percent of the observations. Ammonia, dissolved oxygen, and pH exceeded established criteria in less than 5 percent of the observations (U.S. Environmental Protection Agency website 1999).

Contaminants, Fish Kills, and Health Advisories

Groundwater in Lanagan and Noel was found to have radium levels in excess of established drinking water standards (Barnett et al. 1985). Another problem in the Elk River basin is hydrogen sulfide in domestic wells (Barnett et al. 1985). Soil and tank dioxin residue from a defunct wastewater school at Neosho may affect Buffalo Creek (MDNR 1985). The Arkansas Geological Commission (AGC) is recommending deep groundwater wells in northwest Arkansas due to concerns about nitrate contamination of shallow groundwaters (AGC, pers. comm.).

A study was completed on the water quality of 40 wells in the watershed between August 1990 and April 1992. The study was initiated over the growing concern about large numbers of confined animals in McDonald County and the threats they may pose to groundwater quality. The study found that 25% of the wells sampled had unsatisfactory fecal coliform counts. Results from samples collected during this period were compared to similar samples from the 1960s. These comparisons suggest nitrate levels in the Springfield aquifer, underlying McDonald County, have increased (MDNR 1996).

Water quality problems associated with increased urban development are an ongoing concern in the Little Sugar Creek sub-basin (MDNR 1985 and MDNR 1996). Population increases in Benton County, Arkansas (chiefly around the Bentonville area) are suspected as the primary reason for increased nutrification and algal growth in Little Sugar Creek. Other sources of pollutants in the area are pasture used for poultry waste application, instream gravel removal, and road construction (ADPCE 1996).

Lakes in the Bella Vista development are fertilized to increase sportfish production. These combined influences probably contribute to the excessive nutrient loading seen in Little Sugar Creek. The Arkansas portion of the watershed has experienced significant urban development (U.S. Census Bureau Home Page 1998), while the Missouri portion of the watershed remains more rural in nature. This may be changing as urbanization expands from northwest Arkansas into southwest Missouri.

Reports of pollution and fish kills has increased over the past 15 years. There may be several reasons including increased pollution events, increased environmental awareness and activism, better monitoring by state and federal agencies, or a combination of these factors. The potential for pollution events from confined agriculture operations has significantly increased since the early 1980s. Recurring spills from poultry processing plants in the basin have caused problems in area streams. Animal feeding operations problems relating to animal waste management and disposal have been publicized in the media from many areas of the United States and in Missouri. There are also vocal citizen groups in the Elk River basin that have been active in pursuing agricultural pollution related issues. These circumstances have probably sensitized and polarized the residents in the area concerning pollution from agriculture and related industries. Table 6 lists pollution investigations involving MDC from 1977 through 1998. The table is divided into two sections. Before 1982 there was very little confined animal agriculture in the basin. Since 1982 there has been tremendous growth in the confined animal industry. All fish in the Elk River basin are considered safe to eat in any amount (MDOH 1999).

Water Use

Water for domestic use in the Elk River basin is often drawn from groundwater sources. Precipitation and runoff easily percolate through area soils and rapidly recharge groundwater aquifers. The ready infiltration of precipitation and runoff can lead to contamination of groundwater supplies if good watershed stewardship practices are not followed.

There is one public water supply district in the Elk River Basin in Missouri (MDNR 1986). Most communities in the Missouri portion of the basin obtain water from wells (Table 7). Figure 16 shows the location of permitted wells within the Missouri portion of the Elk River basin.

Water use in the Elk River basin in Missouri is about 2.2 trillion gallons per year. Public and domestic use accounts for 1.4 trillion gallons, industrial/commercial use 409 million gallons, and agriculture for 384 million gallons (DuCharme and Miller 1996).

Point Source Pollution

Missouri Clean Water Commission (MCWC 1974) testing of streams in the Elk River basin found very little variation in chemical and bacteriological parameters. A small elevation in coliform bacteria counts was observed in Indian Creek above Highway 71 near Anderson, Missouri. Effluent from a poultry processing plant and cheese plant were indicated as the reason for reduced water quality. A report by the MDNR in 1976 mentioned that these two industries had ceased operation, and an improvement in water quality was expected. Intermittent gravel mining was also mentioned as causing occasional turbidity problems when it was operating in Indian Creek. This was the only site that was described as not having excellent water quality in the Elk River basin in Missouri (MDNR 1976).

Other water quality concerns are nutrient loading from the Arkansas portion of the watershed to Little Sugar Creek and high levels of nitrate in springs and streams with the potential for CAFO related toxic levels of ammonia in the Little Sugar Creek and Big Sugar Creek sub-basins (MDNR 1985).

Water quality concerns associated with point sources were listed in the Missouri Water Quality Basin Plan (MDNR 1996). The problems associated with point source discharges at this time included: exceeding fecal coliform standards from the Anderson wastewater treatment facility (WWTF); 0.6 miles of stream impacted by the Goodman WWTF; 5.5 miles of stream impacted by the Neosho South WWTF; 0.2 miles of stream impacted by the Pineville WWTF; seepage to a road ditch from an unsewered portion of Fairview; foam and odor problems from a Hudson poultry processing plant; lime deposits in a stream from Lanagan Quarry; sludge and erosion problems associated with the Newton-McDonald county landfill; red algae growth and lowered benthic diversity in Cave Spring Branch caused by Simmons poultry processing plant; 0.5 miles of stream impacted by Noel Water Company; over-application of irrigation water by Wheaton WWTF; and 17 recorded incidents associated with corporate farming, including discharge of waste to streams and poor manure spreading practices (MDNR 1985).

The Clean Water Act requires wastewater dischargers to have a permit establishing pollution limits, and specifying monitoring and reporting requirements. National Pollutant Discharge Elimination System (NPDES) permits regulate household and industrial wastes that are collected in sewers and treated at municipal wastewater treatment plants. These permits also regulate industrial point sources and concentrated animal feeding operations that discharge into other wastewater collection systems or that discharge directly into receiving waters. Table 8 lists NPDES permitted point source discharges in the Elk River basin.

The Toxic Release Inventory (TRI) is an EPA generated source of information about toxic chemicals that are being used, manufactured, treated, transported, or released into the environment from various sources. Table 9 lists facilities in the Elk River basin that are monitored as part of the TRI system.

Hazardous waste information is tracked by state and federal agencies as part of the Resource Conservation and Recovery Act (RCRA). EPA maintains this information in a database called the Resource Conservation and Recovery Information System (RCRIS). Table 10 lists various facilities in the Elk River basin that generate, transport, treat, or dispose of hazardous waste that are monitored under RCRA.

Air emissions of pollutants is reported on as part of the Aerometric Information Retrieval System (AIRS). The AIRS facility subsystem (AFS) contains information on compliance and emissions of facilities with air pollution point sources that are monitored by EPA and/or state regulatory agencies. Table 11 lists facilities that are monitored under the AIRS/AFS system in the Elk River basin.

Non-Point Source Pollution

Animal Feeding Operations

The Elk River basin is an area of low human population but intense confined animal agriculture. Corporate farming, concentrated poultry and hog operations, are the largest water quality concern in the

watershed. The main concern associated with these operations are the large amounts of land-applied waste and the potential for direct contamination from animal waste lagoons. The majority of the animal feeding operations in the watershed produce poultry. Processing plants associated with the confined animal industry have negatively impacted water quality in streams of the Elk River watershed.

The Missouri Department of Natural Resources (MDNR) tracking records indicate that there were six permitted animal feeding operations in the watershed in 1982, with a human population equivalent (PE) of 94,724. Population equivalent (PE) is a measurement that converts waste of biological origin to the equivalent amount of human population needed to cause the same effect. In 1985 free-ranging livestock (cattle) were listed as the main concern and confined livestock second (MDNR 1985). In 1985 the number of hogs and cattle in the watershed was estimated to produce 1,559,000 PE, and the poultry operations in the watershed were estimated to produce 177,800 PE of waste. The total estimated population equivalent waste produced by livestock and poultry in the watershed was 1,736,800 in 1985 (MDNR 1985).

In 1995 animal confinement waste was listed as a "basin-wide concern" with no mention of free-ranging livestock (MDNR 1996). By 1998 there were 265 animal feeding operations (4,417 % increase over 1982) in the watershed (MDNR 1998a). Of these confinement operations, 252 were poultry. They produced estimated wastes of 1,374,984 PE (MDNR 1998a). There are an estimated 90,064 head of cattle in the watershed with an estimated PE of 1,116,793 (MASS 1998). The two combined are estimated to produce waste equal to that of 2,491,777 people. This estimate may be low considering animal feeding operations that house less than 7,000 animal units are not required to hold permits or letters of approval (LOA) and the number of poultry and hogs raised without permit or LOA are not part of this figure. Parts of the Elk River basin that lie in Arkansas and Oklahoma are also not included in these estimates, so they are undoubtedly higher than the figures presented. Known information on animal feeding operations in the Elk River basin can be found in Appendix B.

Animal feeding operations that have more than 7,000 animal units in Missouri are regulated by MDNR. MDNR animal feeding operation regulations require (based on the number of animal units) a specified area of vegetated land be available and used for the spreading of waste. If enough land is not available, the waste must be hauled and spread elsewhere, sold, or contained in closed lagoons. The increased number of animal feeding operations in the watershed are related to increased land conversion to pasture or crop land. Land application of animal waste (primarily poultry litter) has added to soil productivity and improved pasture and hay production. These elements have led to an unquantified increase in land clearing and cattle production (G. Parsons and V. Kugler, MDNR, pers. com.). Arkansas regulates liquid waste storage and disposal, while dry litter handling and disposal is unregulated.

George Parsons (MDNR, pers. comm.) indicated that many animal feeding operation operators, who land apply dry waste, may over-apply the manure. In Arkansas the disposal of dry litter is not regulated so the amount applied is unknown. Phosphorus contamination of streams in the watershed is inevitable if wastes are over-applied. This will probably increase the miles of streams in the Elk River basin that do not meet water quality standards in the future.

Free-ranging cattle and problems associated with them, including waste introduced to surface and groundwater, stream corridor destruction, and increased soil erosion, are concerns in the Elk River basin. Observations made during an April 1998 flyover of the basin confirmed that large numbers of cattle were present. Subsequent conversations with MDNR personnel, responsible for regulating and inspecting animal feeding operations, indicate that a symbiotic relationship exists between corporate agriculture and other agricultural land use practices. With an increase in the number of animal feeding operations, an increase in clearing for pasture and commensurate increase in cattle numbers occurs (G. Parsons and V. Kugler, MDNR, pers. comm.).

Results from the United States Census of Agriculture (NASS 1992) found that Barry ($95,299,000), Newton ($84,209,000), and McDonald ($80,162,000), were the top three Missouri counties for market value of livestock and poultry products. In 1997 McDonald ($153,519,000), Barry ($147,844,000), and Newton ($117,404,000) counties ranked second, third, and fourth respectively, in market value of

livestock and poultry products (NASS 1998). These are further examples of the expanding poultry and livestock industry in the basin.

Erosion

Sheet and rill erosion on tilled lands is 13-18 tons/acre/year, pasture 5-9 tons/acre/year, and ungrazed forest less than 0.5 tons/acre/year. Gully erosion is slight, with less than 100 tons/mi2/year. Sheet erosion for all lands within the Elk River basin averages 4.4 tons/acre/year. Sediment yield by streams in the Elk river basin is 1.4 tons/acre/year, primarily from sheet and rill erosion (Anderson 1980). Erosion is not considered to be a severe problem in the Elk River basin (MDNR 1985 and MDNR 1996). Helicopter video taken in the spring of 1998 revealed localized streambank erosion problems throughout the watershed.

Figures from 1973 indicate that 5% to 10% of the land in the watershed was in cultivation, with about the same amount in pasture production. Watershed land use was listed as 35% row crops and pasture and 65% forested from 1985 through 1995 (MDNR 1985; MDNR 1996). Land in cultivation and pasture production has probably increased throughout the watershed as the number of animal feeding operations has increased. Considerably more land has been cleared for pasture production, and the balance between pasture/row crop and forest land use in now closer to 50:50 (George Parsons, MDNR, pers. comm.).

Most riparian clearing is localized, and problems associated with streambank erosion occur at various sites throughout the watershed. Lost Creek and the upper one-third of Indian Creek were areas with noticeably poor or missing riparian corridors. A larger than normal gravel bedload was observed in Big Sugar Creek.

Urbanization

Water quality problems associated with increased urban development are an ongoing concern in the Little Sugar Creek sub-basin (MDNR 1985; MDNR 1996). Little Sugar Creek headwaters originate in the Bentonville area and then flow through the Bella Vista retirement community before entering Missouri. The cities of Bella Vista and Bentonville, Arkansas had a 1990 combined population of 21,340 people. The entire population of McDonald County, Missouri in the same year was 16,938. The 1980 population of Benton County, Arkansas, of which about half lies in the watershed, was 78,115. The 1990 Benton County, Arkansas, population was 97,499 (25% increase). It increased to 120,932 (55% increase) in 1995, and 134,162 (72% increase) in 1998. Much of this increase has been in the Bentonville and Bella Vista areas. McDonald County's population was 14,917 in 1980, 16,938 (13% increase) in 1990, 18,553 (24% increase) in 1995, and 19,887 (33 % increase) in 1998 (U.S. Census 1998). It appears that urbanization may be expanding from northwest Arkansas into southwest Missouri. Population increases in the Arkansas portion of the Elk River basin will affect Missouri waters. Increasing nuisance algae has been noted in Little Sugar Creek in Missouri (MDNR 1996). Possible problems with reduced flows from Arkansas into the Missouri portion of the watershed have also become a concern. Decreased flows have the potential to negatively affect water quality and aquatic life in the watershed.

Mining

Gravel mining (including removal of gravel from streambeds) occurs throughout the Elk River basin. Little Sugar Creek and its tributaries appear to have the most intensive gravel mining of all the sub-watersheds in the basin. There are many small localized areas where it appears the landowner has removed gravel from or re-arranged gravel bars to use on farm roads and/or try to prevent bank erosion. Another type of rock mining that is significant in the Elk River basin is limestone quarrying. Several large limestone quarries are found in the basin.

Mining of lead, zinc, and tripoli was conducted in the northernmost areas of the basin (part of the tri-state mining district). Most of this mining activity has ceased, but old mine shafts and mine tailings can be

found in the upper reaches of the Indian Creek sub-basin and Buffalo Creek sub-basin. These areas may create water quality problems with leaching of materials and by providing avenues for mixing of surface waters with groundwater.

Known information on gravel, limestone, and mineral mining in the Elk River basin is presented in Table 12. Figure 17 presents the location of mines scattered throughout the basin.

Table 6. Fish kills and water pollution investigations in the Elk River basin, 1970 - 1998.

Date	Stream	County	# of Fish	Est. value	Cause/Source
July 07, 1981	Miser Hollow Branch	McDonald			Petroleum
July 29, 1980	Elk River	McDonald			grain
Nov. 20, 1978	Elk River	McDonald			septic tank seepage
Nov. 20, 1978	Little Sugar Creek	McDonald			sewage effluent/silt
Pre-1982 Total			0	0.00	
Oct. 13, 1998	Cave Spring Branch	McDonald	8	$4.02	poultry processing waste
Sep. 3, 1998	Elk River	McDonald			ammonia
Jul. 14, 1998	Elk River	McDonald	250-		sewage suspected
Apr. 2, 1998	Honey Creek	McDonald	300 mussels		concrete
Feb. 24, 1998	Cave Spring Branch	McDonald	0		poultry processing waste
Jul. 28, 1997	Elk River	McDonald			high temp./low flow
May 7, 1997	Elk River				unknown
Aug. 9, 1996	Thief Hollow Creek	McDonald			hydraulic fluid
Jul. 26, 1996	Butts Ponds	McDonald			poultry manure
Mar. 20, 1996	Elk River (floodplain)	McDonald			food processing wastes
Sep. 25, 1995	Elk River	McDonald			municipal wastewater
Oct. 7, 1994	Little Sugar Creek	McDonald			diesel fuel
Oct. 22, 1994	Stogdon Creek	McDonald			Poultry waste
Dec. 20, 1991	Honey Creek	McDonald			petroleum
Aug. 09, 1989	Little Sugar Creek	McDonald	0		mining
Mar. 13, 1987	Cave Springs Branch	McDonald	317	S50.62	Poultry waste

Date	Stream	County	# of Fish	Est. value	Cause/Source
Dec. 08, 1986	Indian Creek	McDonald	0	0	railroad
May 12, 1985	Buffalo Creek	McDonald	0	0	unknown
Apr. 27, 1984	Indian Creek	McDonald	0	0	municipal sewage
Dec. 09, 1983	Indian Creek	McDonald	unknown	0	Dodecyl benzene/railroad
Aug. 08, 1982	Patterson Creek	McDonald			
Post-1982 Total			325	$54.64	

Table 7. Municipal water supplies in the Elk River basin in Missouri.

Community	Source	Capacity (million gallons/day)
Seneca	Well	1-10
Goodman	Well	Less than 25
Stella	Well	Less than 25
Lanagan	Well	Less than 25
Pineville	Well	Less than 25
Anderson	Well	.25-1.0
Southwest City	Well	.25-1.0
Noel	Well	1/10
Seligman	Well	Less than 25
Washburn	Well	Less than 25

Source: MDNR (1986).

Figure 16. Permitted wells and wastewater treatment facilities in the Elk River basin.

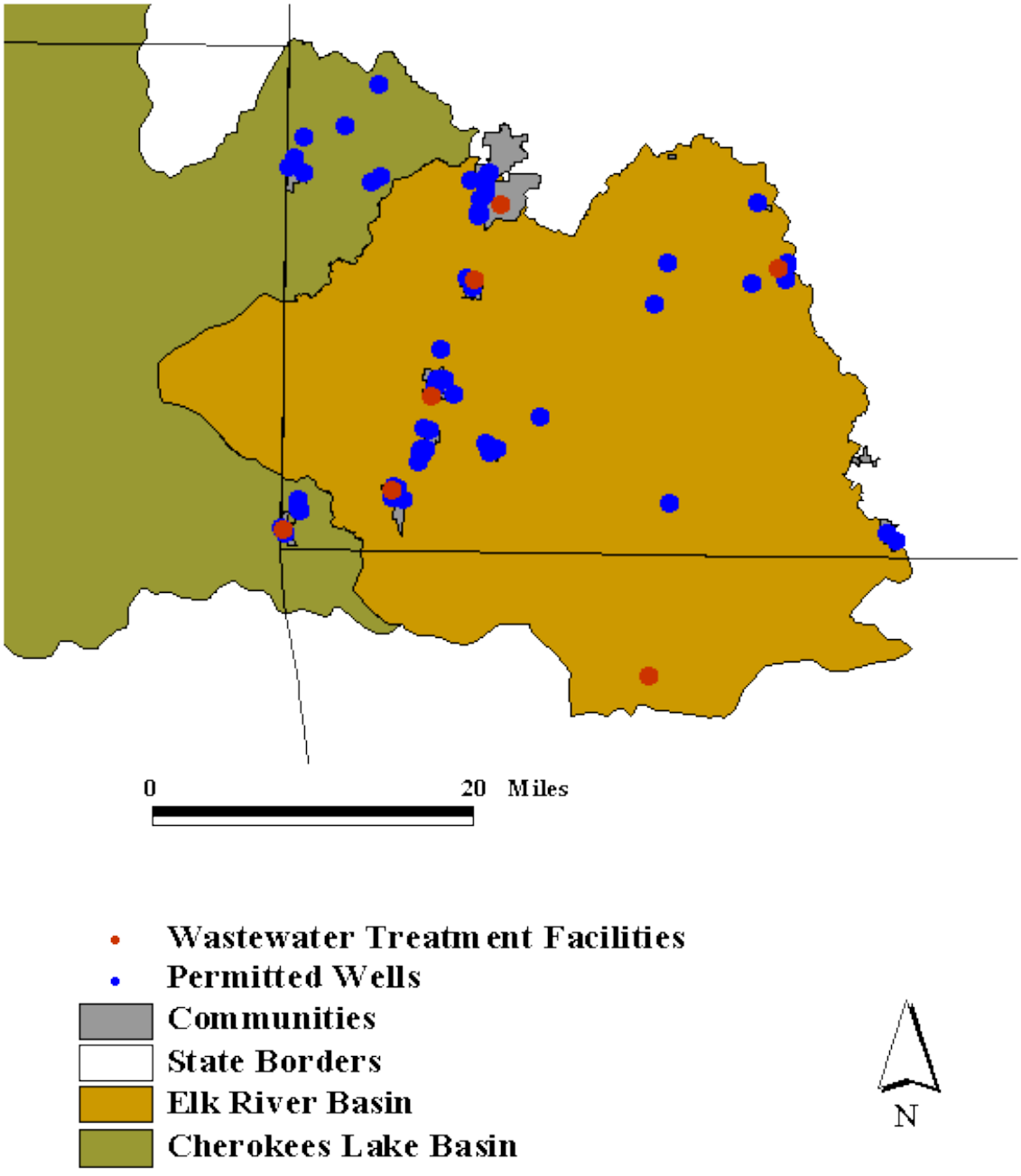


Table 8. Permitted point source discharges in the Elk River basin.

Facility	Type Facility	Design PE1	Receiving Stream	NPDES Permit
Anderson	1 - Cell Lagoon		Indian Creek	IMO0025801
Goodman #1	1 - Cell Lagoon		Tributary of Buffalo Creek	IMO0040771
Goodman #2	1 - Cell Lagoon		Tributary of Indian Creek	IMO0040789
Goodman #3	1 - Cell Lagoon		Tributary of Indian Creek	IMO0040797
Neosho South	Trickling filter-Tertiary	17,647	Buffalo Creek	IMO0039934
Noel	2 - Cell Lagoon		Elk River	IMO0054721
Seneca	2 - Cell Lagoon		Lost Creek	IMO0023035
South West City (Domestic)	2 - Cell Lagoon		Honey Creek	IMO0036765
South West City (Industrial Park)	Aerated Lagoon	10,000	Cave Spring Branch	IMO0036773
Stella	2 - Cell Lagoon		No Discharge	LA2240
Wheaton	1 - Cell Lagoon		Tributary of S. Indian Creek	IMO0041041
Teledyne			Buffalo Creek	IMO0002518
Linde Company			Buffalo Creek	IMO0083411
Noel Water Company	2 - Cell Lagoon and Polishing Lagoon	32,250	Elk River	IMO0002500
Lanagan Housing Authority	Extended Aeration Plant	24	Tributary of Indian Creek	IMO0049948
Noel Suds Parlor	1 - Cell Lagoon	42	Elk River	IMO0082741
Pineville Laundry	Rock Filter		Elk River	
Pineville Housing Authority	Extended Aeration Plant	42	Dog Hollow Creek	IMO0037028
Browning Laundry	1 - Cell Lagoon	46	Tributary of Big Sugar Creek	

Facility	Type Facility	Design PE1	Receiving Stream	NPDES Permit
				IMO0049468
Edgewaters Enterprises Inc	Septic Tank and Sand Filter	5	Tributary of Buffalo Creek	IMO0082376
Ozark Hillbilly Mobile Home Park	2 - Cell Lagoon	15	Tributary of Buffalo Creek	IMO0084531
Benton County Stone Company			Tributary of Butler Creek	AR0046639
City of Bentonville			Town Branch	AR0022403
City of Pea Ridge			Otter Creek	AR0020672
City of Sulphur Springs			Butler Creek	AR0036480
Village Wastewater Company - North			Little Sugar Creek	AR0034258
Village Wastewater Company - Inc.			Little Sugar Creek	AR0034266

1 - Human Population Equivalent

Source: ADPCE (1996) and MDNR (1998a).

Table 9. Toxic release inventory facilities in the Elk River basin.

Facility	Facility ID	Address	City	State
Bentonville Casting Co.	ARD983266792	1019 SE 8th Street	Bentonville	AR
Cooper Furniture Industries Inc.	MOD985774629	150 W. Boyer Street	Goodman	MO
Foam Corporation	ARD983286709	3535 Hudson Road	Rogers	AR
Hudson Foods Inc.	MOD985774728	Hwy 59 N. & DD Hwy	Noel	MO
Kraft General Foods	ARD040628919	507 SE E Street	Bentonville	AR
La Z Boy Midwest Chair Company	MOD049563273	4301 Howard Bush Drive	Neosho	MO
Premier Turbines	MOD050715655	3551 Doniphan Drive	Neosho	MO
Simmons Industries	MOD037130184	Rt. 1	South West City	MO
Sunbeam Leisure Products Company	MOD041707563	4101 Howard Bush Drive	Neosho	MO
Tyson Foods Krispy Kitchens	RD983269127	801 SE 8th Street	Bentonville	AR

Source: U.S. Environmental Protection Agency website (1999).

Table 10. Facilities that are involved with hazardous wastes in the Elk River basin.

Facility	Facility ID	Address	City	State
American Store Interiors	ARD981593882	205 SE S Street	Bentonville	AR
Bentonville Casting Co.	ARD983266792	1019 SE 8th Street	Bentonville	AR
Bentonville City Wastewater Plant	ARD980507586	SE 3rd & D	Bentonville	AR
Concordia Care Center	ARD053142907	7 Professional Drive	Bella Vista	AR
Crowder College - Env. Res. Ctr.	MO0000679738	601 Laclede Avenue	Neosho	MO
CTS Corporation	ARD078907821	1300 SE 8th Street	Bentonville	AR
Ex-Cell of Bentonville	AR0000334862	301 SE J Street	Bentonville	AR
Foam Corporation	ARD983286709	3535 Hudson Road	Rogers	AR
Hudson Foods Inc.	MOD985774728	Hwy 59 N. & DD Hwy	Noel	MO
Kraft General Foods	ARD040628919	507 SE E Street	Bentonville	AR
La Z Boy Midwest Chair Company	MOD049563273	4301 Howard Bush Drive	Neosho	MO
Marble Enterprises Inc.	MOD985768597	Rt. 6 Box 41 M	Neosho	Mo
Old Town One Hour Dry Cleaners	ARD983272642	1009 NW 11th	Bentonville	AR
Precision Manufacturers Inc.	ARD983267253	203 SE S Street	Bentonville	AR
Premier Turbines	MOD050715655	3551 Doniphan Drive	Neosho	MO
Rain Forest Moose Ltd.	AR0000548321	11739 Lindy	Rogers	AR
Rogers Tool Works Inc.	ARD980620256	1602 E Central Street	Bentonville	AR
Sibley Agri Corp.	MOD985792266	Sibley Industrial Park Rd.	Anderson	MO
Sibley Engineering and Manufacturing Co.	MOD053157277	Hwy 59 S	Nowl	MO
Stella Precision Fabricators	MOD098267826	NE edge of town	Stella	MO
Village Dry Cleaners	ARD184741775	27 Riordan Road	Bella Vista	AR

Facility	Facility ID	Address	City	State
Wal-Mart PMDC	ARD983267691	1108 SE 10th Street	Bentonville	AR
Wal-Mart Stores Inc.	ARD138091079	601 Walton Boulevard	Bentonville	AR
Wal-Mart Stores Inc.	ARD983274143	1102 SE 5th Street	Bentonville	AR
Wholesale Transmission	ARD056582273	510 SW A Street	Bentonville	AR

Source: U.S. Environmental Protection Agency website (1999).

Table 11. Facilities with airborne pollutant emissions in the Elk River basin.

Facility	Facility ID	Address	City	State
Bailey Quarries Inc. - Jane Quarry	MO0001553684	South of Hwy 90	Jane	MO
Bates Medical Center	AR0001253210	602 N. Walton	Bentonville	AR
Bella Vista Funeral Home	AR0001253228	2258 Forest Hills Boulevard	Bella Vista	AR
Benton County OES	ARD983278706	201 NE 2nd	Bentonville	AR
Bentonville Casting Co.	ARD983266792	1019 SE 8th Street	Bentonville	AR
Bentonville School District 6	ARD981157068	400 NW 2nd Street	Bentonville	AR
Bentonville School District 6	ARD981157068	400 NW 2nd Street	Bentonville	AR
Central States Press	MO0001565027	Nevada	Hwy 71	MO
Community Publishers, Inc	AR0000818922	209 NW A Street	Bentonville	AR
Concordia Care Center	ARD053142907	7 Professional Drive	Bella Vista	AR
Cooper Furniture Industries Inc.	MOD985774629	150 W. Boyer Street	Goodman	MO
CTS Corporation	ARD078907821	1300 SE 8th Street	Bentonville	AR
Dixieland Inc.	AR0001425552	702 SE 5th	Bentonville	AR
Dynamic Enterprises Inc. - Bill Fleeman	AR0001573237	813 W Central	Bentonville	AR
Evan Electric Motor Center	ARD983268434	2001 N 13th Street	Rogers	AR
First Baptist Church	ARD983278722	200 SW A	Bentonville	AR
FM Corporation	ARD086635018	2503 Walter Tower Road	Rogers	AR
Foam Corporation	ARD983286709	3535 Hudson Road	Rogers	AR
Hudson Foods Inc.	MOD985774728	Hwy 59 N. & DD Hwy	Noel	MO
Jobe Enterprises Inc.	MOD985814516	Rt. 6	Neosho	MO
La Z Boy Midwest Chair Company	MOD049563273	4301 Howard Bush Drive	Neosho	MO

Facility	Facility ID	Address	City	State
Ozark Wood Products Inc.	MOD985813380	Hwy 71 & C	Goodman	MO
Premier Turbines	MOD050715655	3551 Doniphan Drive	Neosho	MO
Simmons Industries	MO0001553403	Hwy 59 S	Anderson	MO
Southwest Lime Co.	MO0001558063	Hwy EE	Lanagan	MO
Southwestern Bell	ARD983278656	Hwy 71	Bella Vista	AR
Southwestern Bell	ARD983285537	207 SW A Street	Bentonville	AR
Wal-Mart Stores Inc.	ARD138091079	601 Walton Boulevard	Bentonville	AR
Walton Enterprises	AR0000815530	125 W Central, Suite 21	Bentonville	AR

Source: U.S. Environmental Protection Agency website (1999).

Table 12. Known information about mines found in the Elk River basin.

Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T-R-Sec.
Carborundum Company	Tripoli	Processing Plant	Inactive			24N-34W-08
Baxter Diggings	Zinc & Lead	Underground	Inactive	3.5	50	25N-33W-01
Baxter Mines	Lead	Underground	Inactive	0.13		25N-33W-04
Carpenter's Shafts	Zinc & Lead	Underground	Inactive	0.75		25N-33W-02
Freeto Quarry	Limestone	Surface	Inactive	7.00		24N-32W-07
Cornwall Diggings	Lead	Underground	Inactive	0.38		26N-33W-36
Sheets Shaft	Zinc & Lead	Underground	Inactive	0.13		26N-33W-36
Sibley Diggings	Lead	Underground	Inactive	0.0	65	24N-34W-08
C. Huber	Lead & Barium	Underground	Inactive	0.0	100	24N-34W-36
Unknown	Limestone	Surface	Inactive		0	24N-33W-36
We-May Corp.	Limestone	Surface	Inactive		0	24N-33W-22
Southwest Lime Co.	Limestone	Surface	Inactive		0	25N-2W-29
Unknown	Lead	Underground	Inactive			25N-33W-02
F & J Knox E. Hatzfield	Zinc & Lead	Underground	Inactive			24N-33W-29
E. Hatzfield	Zinc & Lead	Underground	Inactive			25N-33W-02
Seneca Lead & Zinc Co.	Zinc & Lead	Underground	Inactive	0.25		25N-34W-36
Unknown	Zinc & Lead	Underground	Inactive	0.13		25N-34W-04

Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T-R-Sec.
Unknown	Zinc & Lead	Underground	Inactive			26N-33W-34
E. Olson	Zinc & Lead	Underground	Inactive	0.75	0	26N-33W-34
Unknown	Silicon & Tripoli	Surface	Inactive	2.5	0	25N-33W-26
Carborundum Co.	Silicon & Tripoli	Surface	Inactive		0	25N-33W-25
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	0.25	0	25N-33W-25
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	0.75	0	25N-33W-25
Barnsdall-American	Silicon & Tripoli	Surface	Inactive	0.06	0	25N-33W-15
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	2.5	0	25N-33W-24
Unknown	Silicon & Tripoli	Surface	Inactive	2.25	0	25N-33W-24
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	1.5		25N-33W-23
Unknown	Zinc	Underground	Inactive	0.13		25N-33W-04
Unknown	Silicon & Tripoli	Surface	Inactive	0.38		25N-33W-23
Unknown			Inactive	0.75		26N-33W-36
Unknown		Underground	Inactive	0.63		26N-33W-36
Unknown		Underground	Inactive	1.25		25N-32W-27
Unknown			Inactive	0.75		25N-33W-01
Armstrong & Cravens Quarry	Limestone	Surface	Inactive			21N-33W-22
Jane Quarry	Limestone	Surface	Inactive	6.0		21N-31W-17

Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T-R-Sec.
Jeffers Quarry	Limestone	Surface	Inactive			22N-32W-19
John P. Hughes Quarry	Limestone	Surface	Inactive			21N-33W-22
Joplin-Elk River Stone Co. Quarry	Limestone	Surface	Inactive			21N-33W-14
Lanagan Quarry	Limestone	Surface	Inactive	6.0		22N-33W-36
Lewis Quarry	Limestone	Surface	Inactive			21N-33W-26
Madge Stone Company Quarry	Limestone	Surface	Inactive	0.5		21N-33W-15
Mill Creek Quarry	Limestone	Surface	Inactive			21N-33W-23
Railroad Quarry	Limestone	Surface	Inactive			21N-33W-22
Truitt Quarry	Limestone	Surface	Inactive			21N-33W-01
Unknown	Coal	Surface	Inactive			23N-31W-09
Unknown	Coal	Surface	Inactive			32N-31W-09
Unknown	Iron	Underground	Inactive		30	23N-34W-14
Unknown	Iron & Coal	Underground	Inactive		116	23N-34W-13
Nymo Land & Mining Co.	Lead, Zinc, & Iron	Underground	Inactive		150	23N-32W-18
Unknown	Limestone	Surface	Inactive	2.0		21N-32W-02
Unknown	Limestone	Surface	Inactive			21N-32W-11
Unknown	Limestone	Surface	Inactive			21N-33W-15

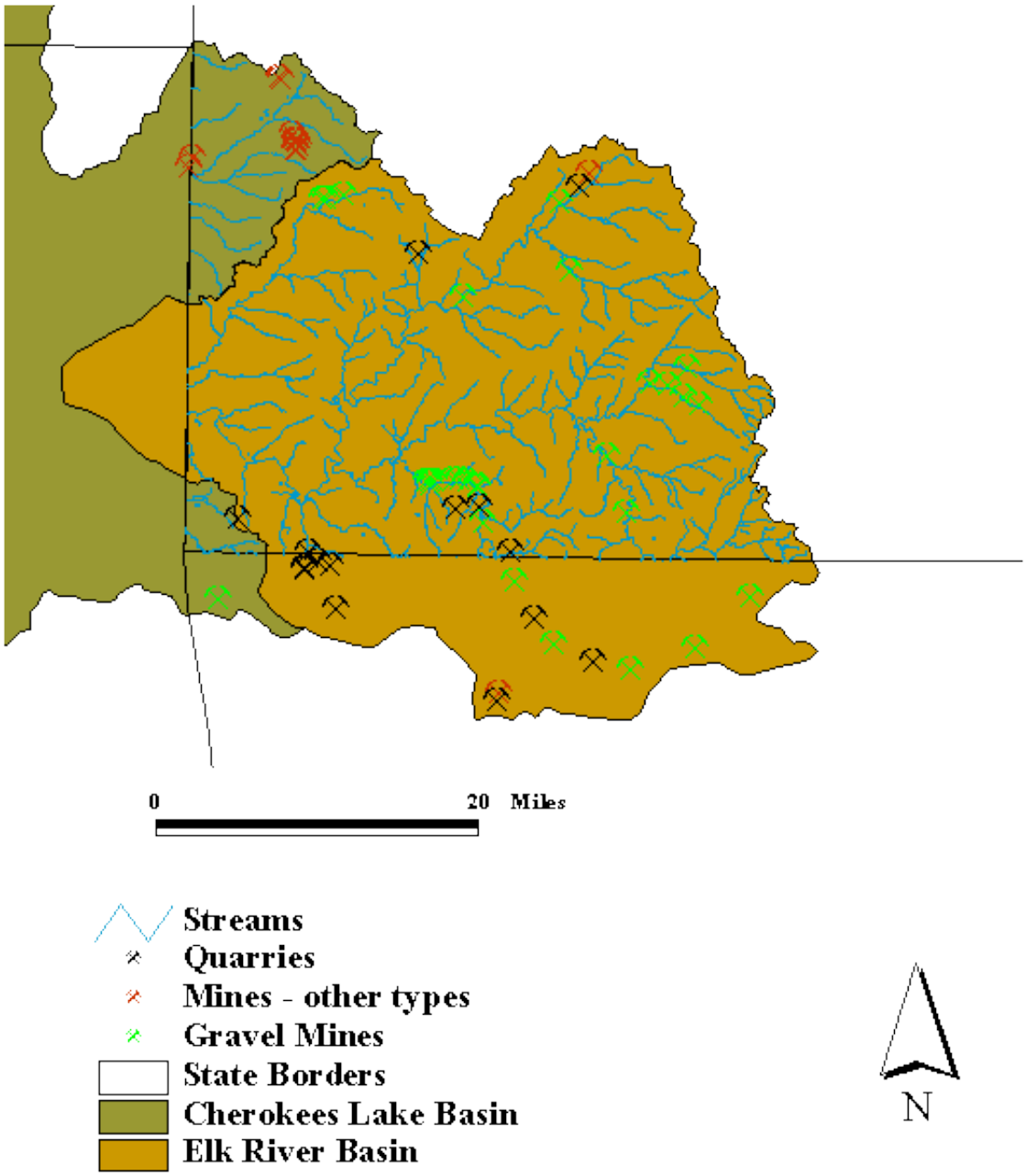
Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T-R-Sec.
Unknown	Limestone	Surface	Inactive			21N-33W-26
Unknown	Limestone	Surface	Inactive			21N-33W-35
Unknown	Limestone	Surface	Inactive			22N-32W-30
Unknown	Zinc	Underground	Inactive		20	23N-34W-26
Unknown	Zinc	Underground	Inactive		60	23N-34W-26
Unknown	Zinc & Lead	Underground	Inactive		220	23N-34W-27
Unknown	Zinc & Lead	Underground	Inactive		25	23N-34W-27
Noel Concrete	Limestone	Surface	Inactive			21N-33W-26
McDonald County Sand & Gravel	Sand & Gravel	Surface	Active	2.0	0	21N-31W-17
M. F. Goswick Lime Co.	Limestone	Surface	Active	5.0	0	21N - 31W - 17
Ozark Heights Crushing	Limestone	Surface	Active	5.0	0	21N-31W-17
Hall & Riley Quarries & Const. Co.	Limestone	Surface	Active	40.0	0	21N-31W-35
Hall & Riley Quarries & Const. Co.	Limestone	Surface	Active	0	0	21N-31W-35
Macco Gravel Co. Inc.	Sand & Gravel	Surface	Active	25.0	0	21N-32W-08
	Limestone					22N-29W-33
Everette Brody	Sand & Gravel	Surface				24N-30W-11

Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T-R-Sec.
Jimmy and Chris Morgan	Sand & Gravel	Surface				23N-34W-13
Jimmy Connor	Sand & Gravel	Surface	Active		0	24N-33W-12
Jimmy Connor	Sand & Gravel	Surface	Active		0	24N-33W-15
Jimmy Connor	Sand & Gravel	Surface	Active		0	24N-33W-14
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N- 31W-21
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-31W-09
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-31W-09
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-31W-07
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-32W-12
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-31W-08
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-32W-12
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-31W-08
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N-32W-12
Zannie Poe	Sand & Gravel	Surface	Active		0	21N-28W-29
Marvin Undernehr	Sand & Gravel	Surface	Active		0	20N-29W-10
Bella Vista Property	Sand & Gravel	Surface	Active		0	
Floyd Wolf Jr.	Sand & Gravel	Surface	Active		0	23N-29W-34

Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T-R-Sec.
McCullah & Sons Construction	Sand & Gravel	Surface	Active		0	22N-29W-10
McCullah & Sons Construction	Sand & Gravel	Surface	Active		0	22N-29W-09
Tillman Sand and Gravel	Sand & Gravel	Surface	Active		0	22N-30W-35
Ellick Garren	Sand & Gravel	Surface	Active		0	23N-31W-07
Sherry Woodard	Sand & Gravel	Surface	Active		0	21N-30W-13
Pea Ridge Gravel	Sand & Gravel	Surface	Active		0	22N-29W-05
McCullah & Sons Construction	Sand & Gravel	Surface	Active		0	22N-29W-06
Martin Henson	Sand & Gravel	Surface	Active		0	21N-32W-12
Kenneth Werries	Sand & Gravel	Surface	Active		0	24N-30W-07
Troy Henson	Sand & Gravel	Surface	Active		0	21N-32W-12

Source: MDNR (1996) and USACOE, pers. comm.

Figure 17. Mines in the Elk River basin



Habitat Conditions

Aquatic Community Classification

The Ozark Highlands are an area of very old, highly weathered, low plateaus. The time span over which the region evolved has created a very physiographically diverse area with many associated unique endemic species (MDC 1998). The Elk River basin is located in the western portion of this area. The Elk River basin as delineated in this document is part of the Ozark-Neosho Division Community, a small portion of the Ozark Aquatic Faunal Region (Pflieger 1989). Streams in the Elk River basin tend to be very clear and more Ozarkian in nature than streams in the northern and western portions of the Neosho Division. Stream gradients are generally less than in other Ozark divisions. Springs tend to be numerous but small. The fish fauna of this division includes several species that are found in no other area of Missouri including redspot chub, bluntface shiner, cardinal shiner, southwestern mimic shiner, western slim minnow, Neosho madtom, Arkansas darter, Neosho orangethroat darter, redfin darter, and channel darter. Other fauna unique to this area are the yellow mud turtle, Neosho midget crayfish, and Neosho mucket mussel (Pflieger 1989).

Channel Alterations

Channel alterations in the basin include modifications to urban stream courses, channelization associated with road and bridge construction, several small impoundments, channel modifications related to gravel removal, and efforts by individuals to control streambank erosion. Larger scale channelization seems to have been concentrated in the Lost Creek and Buffalo Creek drainages. Lost Creek and its tributaries above Seneca, Missouri, have been extensively channelized in an effort to control flooding. Another area where channelization was noticed on topographic maps was in the Big Sugar Creek sub-basin near Pea Ridge, Arkansas. Two other areas of noted channel disturbance are Little Sugar Creek at Bella Vista, Arkansas, and the Elk River along Highway 71 just south of Pineville, Missouri (Gordon 1980). Areas where channelization was apparent on topographic maps are shown in Figure 18. Instream commercial gravel mining operations are scattered throughout the basin. However, they seem to be more prevalent in the Big Sugar Creek and Little Sugar Creek sub-basins. There are several areas of small scale channel disturbance (probably gravel removal) presumably for purposes such as driveway and field road maintenance, beach/bank reshaping, and low water ford maintenance. The cumulative effect of these activities is not known.

Unique Habitats

The only designated natural area in the Elk River basin is Buffalo Hills Natural Area in northwest McDonald County. It is a 340-acre area consisting of dry-mesic and dry chert forest. It is owned and managed by MDC (Kramer et al 1996). Running buffalo clover, a federally endangered species, is present on this area. Several notable natural communities are found in the area encompassed by the Elk River basin including: caves, dry chert forests, dry-mesic chert forests, limestone glades, dolomite glades, shale glades, dry-mesic chert prairies, hardpan prairies, dry limestone/dolomite cliffs, Ozark headwater streams, and Ozark creeks/small rivers.

Improvement Projects

Many contacts about stream improvement projects have been made in the Elk River basin, but relatively few have been constructed. This is due in part to inability or unwillingness by private individuals to commit funds necessary for cost share projects. Also, fluctuations in the availability of government agency funding for these programs has limited installation of projects. Some improvement projects have been completed in the Elk River basin by both government agencies and private landowners.

Public Lands

Three improvement projects have been done on the MDC Deep Ford Access. The first project was completed in 1986. It consisted of a 400' rock blanket, a series of six hard points, and tree planting. It was designed to reduce bank erosion and encourage natural revegetation of the protected bank. Excessive erosion was still occurring downstream of the last hard point in 1987, so additional work was done during the spring and summer of 1988. This consisted of a two row tree revetment using cedar trees and planting of willows and sycamores in an area extending downstream about 75 feet from the last hard point. High water flows washed away several of the anchored cedar trees and a number of the planted trees. The third project consisted of repairing the original revetment, replanting trees, and adding two new revetments between the lower three hard points in 1989. Additional planting of trees was conducted through 1992.

Private Lands

There are four documented projects carried out in the Elk River basin involving private landowners and MDC. One is on the Kings Valley tributary of Big Sugar Creek (T22N, R30W, Sec. 4). A rock blanket and willow stakes were used to stabilize a bank downstream from a low water crossing to protect a spring that is the landowner's water supply. The project was completed in 1994. Another project is located on Indian Creek (T23N, R31W, Sec. 4) and consists of a cedar tree revetment and stream corridor tree planting to stabilize a rapidly eroding bank. This project was completed in 1992. The third project was along Big Sugar Creek (T22N, R32W, Sec. 34) in McDonald County. It consisted of a cedar tree revetment (225 feet long) and two acres of streambank planted with trees. This project was completed in September 1990. Another project done in the Elk River basin was a tree planting and willow staking project covering 800 feet of streambank along Little Sugar Creek (T21N, R32W, Sec. 2).

Another project that will impact water quality and protect a stream in the Elk River basin is a rotational grazing system that utilizes alternative watering and riparian corridor fencing. This project was installed as a cooperative effort between the NRCS and a private landowner. Water is provided for the cattle by a well, pipelines, and water tanks. This allowed a 50-foot wide fenced corridor to protect about 2,800 feet of Sugar Fork Creek in McDonald County (T23N, R32W, Sec. 3) from cattle grazing and watering activity. A second part of the project was a 20-foot wide corridor around a spring that feeds the creek. It was fenced to protect it from cattle activity that would adversely affect water quality in Sugar Fork Creek. This project was completed in June 1998.

Stream Habitat Assessment

Based on information used for MDC Southwest Regional Management Guidelines the following are habitat features of areas found within the Elk River basin. Sub-basins with greater than 50% forest cover include Little Sugar Creek, Big Sugar Creek, and Elk River. (MDC 1998b). The Big Sugar Creek Hills land type association has outstanding large forested blocks (MDC 1998b). Big Sugar Creek Landscape Conservation Area (includes Big Sugar Creek and Elk River sub-basins) is an exceptional region due to the outstanding creek system, its associated rare aquatic fauna, and several caves that are home to endangered bats. It also has great potential for glade and savanna restoration (MDC 1998).

Based on aerial videotape examination, there are some characteristics that apply to most, if not all, streams in the Elk River basin. Wooded riparian corridors in the Elk River basin seem to be a function of terrain. If the land can be safely negotiated by farm equipment, it tends to be maintained as pasture.

Areas of significant tree lined corridor generally are too steep to be used for any other purpose. For example, the corridor is typically a good mixture of trees and shrubs on the bluff side of the river and often pasture will run to the water's edge across from the bluff. In areas where both sides are relatively flat there often is no wooded riparian corridor. Streambank stability is often determined by the quality and width of the streamside wooded corridor. The patchiness of the wooded corridor throughout the Elk River basin probably does very little to stabilize the streambanks. Instead, streambank stability in the Elk River

basin seems to be a function of bedrock, limestone bluffs, and gravel bedloads.

All streams, from the air, appeared to have large gravel bars, shoals, and islands in and along them. Sample site notes throughout the basin mentioned gravel, pebble, and cobble as the dominant substrate materials, corroborating the composition of these depositional areas. Extensive channel braiding was noted in Big Sugar Creek and Little Sugar Creek. These features indicate excessive bedloading. During flood flows this material can be moved, but during normal periods of lower flow it drops out, creating extensive gravel bars/shoals and numerous braided channel areas.

Vehicular activity in stream channels throughout the basin was evident. Large numbers of shallow water fords, and ruts in stream channels could be seen on the aerial video tapes. The combination of firm streambeds and shallow areas likely promote this activity.

Another trait common to all basin streams is free access of ranging cattle. All streams exhibited some symptoms of cattle activity in and along them. This included bank erosion, poorly vegetated riparian corridors, and nutrient enrichment from cattle wastes in and along the stream. Several areas with cattle access to the river were seen between Pineville and Highway 43 during a survey of the Elk River. These areas were sparsely vegetated and had steep banks with large ruts or grooves in them where cattle walked down to water. The upper reaches of Buffalo Creek, Lost Creek, and Indian Creek all had very restricted wooded corridors and exhibited signs of intensive cattle activity.

The following observations for individual streams are based on information recorded during fish collections in 1997 and 1998.

Big Sugar Creek

The reaches sampled along Big Sugar Creek had good to poor streambank stability. The majority of the stream had sections with vertical banks and no vegetation capable of preventing scour. A few locations exhibited excellent streambank stability characterized by good vegetation cover and no vertical banks. Streambank vegetation was dominated by herbaceous vegetation (30 to 40 percent) or no vegetation (20 to 40 percent). Tree cover ranged from 10 to 30 percent and shrub cover from 20 to 30 percent. The width of the wooded riparian corridor exceeded 75 feet in upstream locations, but progressively narrowed downstream to 25 feet or less. Land use in the region varied, but was dominated by pasture. Forest and residential/commercial land uses were present. The substrate was composed of all categories except clay, silt, and bedrock. The gravel, pebble, and cobble forms were dominant.

Buffalo Creek

The reaches of Buffalo Creek sampled had good streambank stability. Most of the reaches had little to no visible erosion. One small section had a vertical bank with no vegetative cover. Streambank vegetation consisted of herbaceous vegetation (40%) interspersed with an equal amount of trees, shrubs, or bare banks (20% each). Land use was pasture for all locations. The upstream location had a wooded stream corridor of less than 25 feet. The downstream location had a wooded corridor width of greater than 100 feet. The substrate consisted of all forms except clay. Pebble and cobble were dominant upstream, while gravel was the dominant substrate downstream. Bedrock was noted only in the downstream location.

Butler Creek

One site was sampled on Butler Creek. The reach had excellent to good streambank stability with no sign of active erosion. Streambank vegetation consisted of 40% herbaceous vegetation, 30% shrub, 25% tree, and 5% had no vegetative cover. The land use for the area was residential/commercial. The width of the wooded corridor varied along the reach sampled. The right bank upstream had over 100 feet of wooded corridor and the left bank, cut by the highway, had 25 feet of corridor with tree cover. Downstream, the city park at Noel reduced wooded corridor widths to less than ten feet. Finer sediments dominated the substrate composition.

Elk River

The streambank stability of the Elk River ranged from good to poor. Upstream, just after the confluence of Big and Little Sugar creeks, streambank stability was poor with little to no vegetation. The streambank cover types were bare bank (40%), herbaceous vegetation (30%), shrubs (20%), and trees (10%). Upstream, the width of wooded corridor, if present, was less than 25 feet. Vertical banks were not noted. Streambank stability increased downstream. Streambanks were covered with herbaceous vegetation (40%), shrubs (30%), and trees (20%). Only ten percent of the streambank was bare. Where present, wooded riparian corridor widths exceeded 50 feet. Land use beyond the corridor was primarily residential/commercial with some forest and row crop. The substrate consisted of all forms except clay and silt, with pebble, gravel, and cobble being the dominant forms.

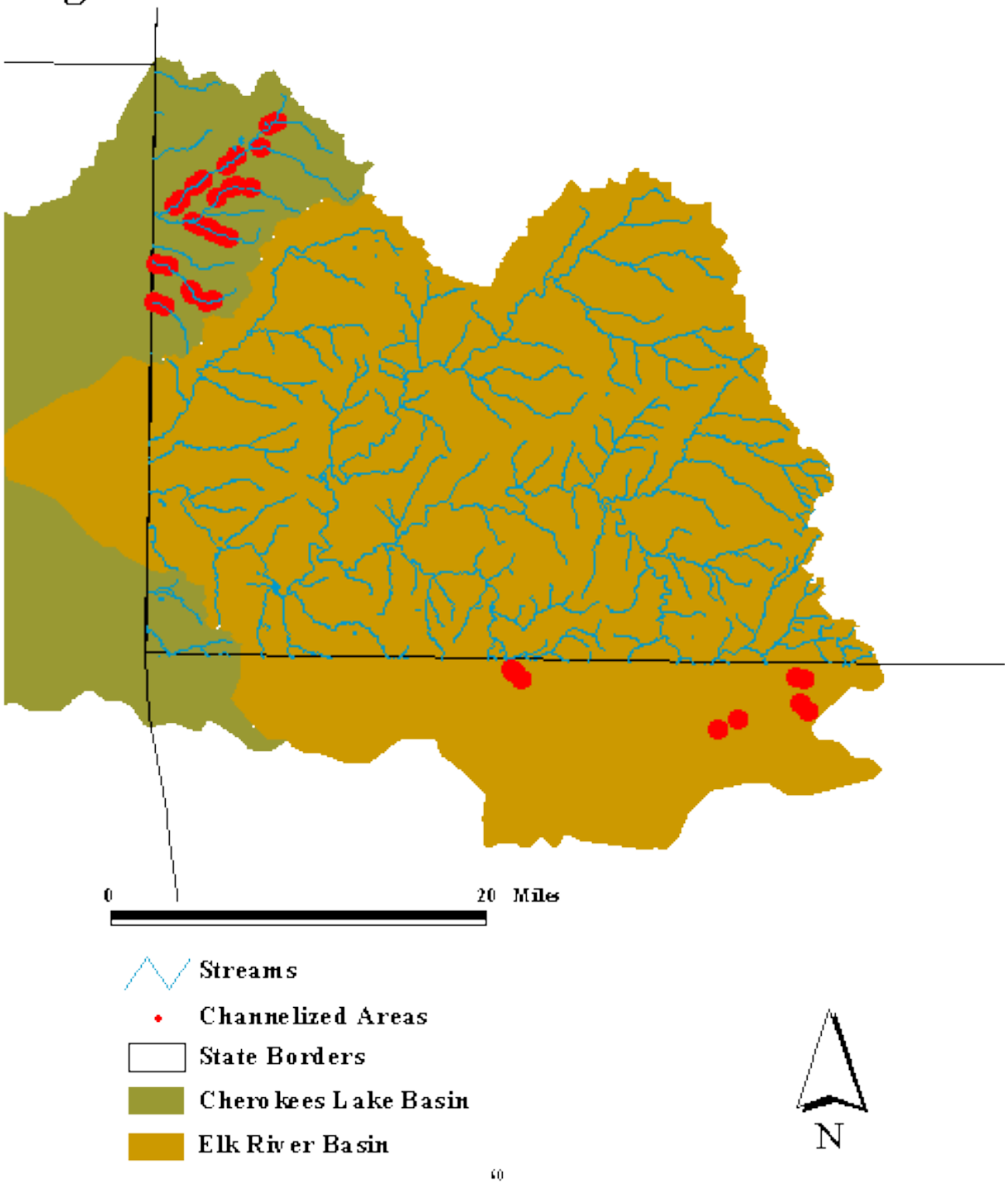
Indian Creek

Streambank stability ranged from excellent to good with no visible signs of erosion. Streambank vegetation was dominated by herbaceous vegetation (40%), shrubs (30%), and trees (20%). Only ten percent of the reaches sampled had no vegetation cover. Predominant land use beyond the corridor was pasture with some row crop and residential use noted. Width of the wooded corridor was greater than 100 feet in most locations. A small section had a wooded stream corridor width of only 25 feet. The substrate composition was dominated by larger forms. One location was primarily bedrock (75%).

Little Sugar Creek

Streambank stability for this stream ranged from good to poor. Several locations had vertical banks with no vegetation. Streambank vegetation consisted of mostly herbaceous vegetation with some shrubs and trees. The land uses consisted of mostly residential/commercial and pasture with a small area set aside as forest. The width of the wooded stream corridor in all locations sampled was greater than 100 feet. The substrate consisted of all forms except clay with gravel, pebble, and cobble as the dominant forms.

Figure 18. Channelization in the Elk River basin.



Biotic Community

Fish Community Data

Aquatic sampling in the Elk River basin has been ongoing since before the initial elements occurrence record (EOR) was written in 1982. Table 13 lists fish that have been collected and identified by sub-basin within the Elk River basin in Missouri using records from the 1930's to present. Collections of fish were also made by the Missouri Department of Conservation's Southwest Regional Staff during 1997 and 1998 (Figure 19). The samples were collected to assess basin-wide fish communities. Thirty-five species of fish were identified from these samples. Appendix C has collections by site and date for the Elk River basin.

Seventy species of fish have been collected from the Elk River basin in Missouri. There are no sample records from the time period 1965-1982 for the Elk River basin. Fifty-nine species were collected prior to 1982 and eleven species have not been collected since 1965. The channel darter was last sampled prior to 1946 and never had a widespread occurrence in the watershed. According to Pflieger (1997) the channel darter probably no longer exists in the watershed. Table 14 lists the species and indicates the time periods in which they were collected. Fifteen species found between 1982 and 1991 were not sampled during 1997-98. These absences may have occurred for several reasons. Only specific sportfish populations were sampled during 1998 samples (N = 2) and non-game fish were not collected. For the majority of the fish missing from the 1997 samples (N = 17), inadequate sampling or sampling error could be factors in their absence. Twelve of the species missing from the 1997 samples, grass carp, common carp, quillback, bigmouth buffalo, river redhorse, black redhorse, golden redhorse, shorthead redhorse, white crappie, black crappie, warmouth, and freshwater drum are large species which readily avoid seine hauls and are commonly found in habitats too brushy or deep to seine. Seining was the only method used in these samples, and is probably the reason for their absence. Only one fathead minnow has been collected (in 1984), and Pflieger (1997) indicates that most records of fathead minnows from the Ozark faunal region, including the Elk River basin, are introductions from bait buckets, and few self-sustaining populations exist. Ozark cavefish usually are not captured unless sought in caves, or near spring openings flowing from a subterranean source during high flow or pollution related events. Logperch was the other species not captured during seining in 1997.

It is possible that some species are being lost from the watershed. Bluntface shiners are a state watch list species, and Pflieger (1997) lists them as more common and widespread prior to the 1950s. They were sampled at five locations prior to 1964. Bluntface shiners were last collected by MDC personnel in the watershed in 1991 in the lower Elk River. The USGS conducted a series of surveys on the lower Elk River as part of a water quality study (NAWQA) and captured low numbers of bluntface shiners in 1994 and 1995 (J. Petersen, USGS, pers. comm.). The same site was surveyed by MDC in 1997 with no bluntface shiners collected. Wedgespot shiners were last collected by MDC personnel in the watershed in 1991. The USGS conducted a series of surveys on the lower Elk River as part of a water quality study (NAWQA) and collected low numbers of wedgespot shiners in 1993, 1994, and 1995 (J. Petersen, USGS, pers. comm.). It appears that bluntface shiners and wedgespot shiners are still present in the lower Elk River but are not as abundant as they were historically. Fish surveys seem to indicate a healthy fish population. Declines in some species have occurred, but may not be unique to the Elk River system.

Table 13. Fish species list by stream for the Elk River basin.

Common Name	Species	Lost	Buffalo	Indian	Elk	Butler	B. Sugar	Mikes	L. Sugar
Rock bass	*Ambloplites rupestris*		X	X	X	X	X	X	X
Ozark cavefish	*Amblyopsis rosae*	X	X						
Black bullhead	*Ameirus melas*			X	X				
Yellow bullhead	*Ameirus natalis*			X	X				
Freshwater drum	*Aplodinotus grunniens*				X				
Central stoneroller	*Campostoma pullum*	X	X	X	X	X	X	X	X
River carpsucker	*Carpiodes carpio*				X				
Quillback	*Carpiodes cyprinus*				X				
White sucker	*Catostomus commersoni*		X	X					
Banded sculpin	*Cottus carolinae*	X	X	X	X	X	X	X	X
Grass carp	*Ctenopharyngodon idella*				X				
Blue sucker	*Cycleptus elongatus*				X				
Bluntface shiner	*Cyprinella camura*		X	X	X				
Red shiner	*Cyprinella lutrensis*		X		X				
Common carp	*Cyprinus carpio*				X				
Gizzard shad	*Dorosoma cepedianum*				X				
Gravel chub	*Erimystax x-punctatus*				X				
Greenside	*Etheostoma*			X	X	X	X		X

Common Name	Species	Lost	Buffalo	Indian	Elk	Butler	B. Sugar	Mikes	L. Sugar
darter	*blennioides*								
Fantail darter	*Etheostoma flabellare*	X	X	X	X	X	X	X	
Johnny darter	*Etheostoma nigrum*			X					
Stippled darter	*Etheostoma punctulatum*		X	X	X	X		X	X
Orangethroat darter	*Etheostoma spectabile*	X	X	X	X	X	X	X	X
Speckled darter	*Etheostoma stigmaeum*			X					X
Banded darter	*Etheostoma zonale*			X	X		X		X
Northern studfish	*Fundulus catenatus*		X	X	X	X	X	X	X
Blackstripe topminnow	*Fundulus notatus*		X	X	X		X		X
Plains topminnow	*Fundulus sciadicus*	X							
Western mosquitofish	*Gambusia affinis*	X	X	X	X		X		
Northern hog sucker	*Hypentelium nigricans*		X	X	X	X	X		X
Southern brook lamprey	*Ichthyomyzon gagei*				X				
Channel catfish	*Ictalurus punctatus*			X	X				X
Bigmouth buffalo	*Ictiobus cyprinellus*				X				
Black buffalo	*Ictiobus niger*		X		X				
Brook silverside	*Labidesthes sicculus*			X	X				X
Longnose gar	*Lepisosteus osseus*				X				
Green sunfish	*Lepomis cyanellus*	X		X	X		X		X
Warmouth	*Lepomis gulosus*				X				

Common Name	Species	Lost	Buffalo	Indian	Elk	Butler	B. Sugar	Mikes	L. Sugar
Orangespotted sunfish	*Lepomis humilis*			X					
Bluegill	*Lepomis macrochirus*		X	X	X	X		X	X
Longear sunfish	*Lepomis megalotis*	X	X	X	X	X	X		X
Redear sunfish	*Lepomis microlophus*			X					
Cardinal shiner	*Luxilus cardinalis*	X	X	X	X	X	X	X	X
Redfin shiner	*Lythrurus umbratilis*			X					
Smallmouth bass	*Micropterus dolomieu*		X	X	X	X	X	X	X
Spotted bass	*Micropterus punctulatus*				X				
Largemouth bass	*Micropterus salmoides*		X	X	X	X			X
White bass	*Morone chrysops*				X				
Shorthead redhorse	*Moxostoma macrolepidotum*				X				
River redhorse	*Moxostoma carinatum*				X				
Black redhorse	*Moxostoma duquesnei*		X	X	X		X		X
Golden redhorse	*Moxostoma erythrurum*				X				
Redspot chub	*Nocomis asper*	X	X	X	X	X	X	X	X
Hornyhead chub	*Nocomis biguttatus*		X						
Golden shiner	*Notemigonus crysoleucas*			X					
Bigeye chub	*Notropis amblops*			X	X	X	X		X
Bigeye shiner	*Notropis boops*			X	X	X	X		X
Wedgespot	*Notropis greenei*			X	X				

Common Name	Species	Lost	Buffalo	Indian	Elk	Butler	B. Sugar	Mikes	L. Sugar
shiner									
Ozark minnow	*Notropis nubilus*	X	X	X	X	X	X		X
Rosyface shiner	*Notropis rubellus*	X	X	X	X	X	X		X
Slender madtom	*Noturus exilis*	X	X	X	X	X	X	X	X
Rainbow trout	*Oncorhynchus mykiss*			X					
Logperch	*Percina caprodes*				X				
Channel darter	*Percina copelandi*				X				
Southern redbelly dace	*Phoxinus erythrogaster*	X	X	X			Xx		X
Bluntnose minnow	*Pimephales notatus*		X	X	X	X	X		
Fathead minnow	*Pimephales promelas*					X			
White crappie	*Pomoxis annularis*			X	X				
Black crappie	*Pomoxis nigromaculatus*				X				
Flathead catfish	*Pylodictus olivaris*				X				
Creek chub	*Semotilus atromaculatus*	X	X	X X	X	X	X	X	

Table 14. Fish species list by stream for the Elk River basin.

Common Name	Scientific Name	Period1
Southern brook lamprey	*Ichthyomyzon gagei*	B
Longnose gar	*Lepisosteus osseus*	C, D
Gizzard shad	*Dorosoma cepedianum*	A, C, D
Rainbow trout	*Oncorhynchus mykiss*	A
Central stoneroller	*Campostoma pullum*	A, B, C, D, E
Grass carp	*Ctenopharyngodon idella*	C
Common carp	*Cyprinus carpio*	C, D
Bluntface shiner	*Cyprinella camura*	A, B, D
Red shiner	*Cyprinella lutrensis*	A, D
Gravel chub	*Erimystax x-punctatus*	A, B, D
Cardinal shiner2	*Luxilus cardinalis*	A, B, C, D, E
Redfin shiner	*Lythrurus umbratilis*	A
Redspot chub2	*Nocomis asper*	A, B, C, D, E
Hornyhead chub	*Nocomis biguttatus*	D
Golden shiner	*Notemigonus crysoleucas*	B
Bigeye chub	*Notropis amblops*	A, B, D, E
Bigeye shiner	*Notropis boops*	A, B, D, E
Wedgespot shiner	*Notropis greenei*	A, B, D
Ozark minnow	*Notropis nubilus*	A, B, C, D, E
Rosyface shiner	*Notropis rubellus*	A, B, C, D, E
Southern redbelly dace	*Phoxinus erythrogaster*	A, B, C, D, E
Bluntnose minnow	*Pimephales notatus*	A, B, C, D, E
Fathead minnow	*Pimephales promelas*	C
Creek chub	*Semotilus atromaculatus*	A, B, D, E
River carpsucker	*Carpiodes carpio*	B
Quillback	*Carpiodes cyprinus*	C
White sucker	*Catostomus commersoni*	A, B
Blue sucker	*Cycleptus elongatus*	A

Common Name	Scientific Name	Period1
Northern hog sucker	*Hypentelium nigricans*	A, B, C, D, E
Bigmouth buffalo	*Ictiobus cyprinellus*	C
Black buffalo	*Ictiobus niger*	A
River redhorse	*Moxostoma carinatum*	B, C
Black redhorse	*Moxostoma duquesnei*	A, B, C, D
Golden redhorse	*Moxostoma erythrurum*	A, B, C, D
Shorthead redhorse	*Moxostoma macrolepidotum*	A, C
Black bullhead	*Ameiurus melas*	B, D
Yellow bullhead	*Ameiurus natalis*	B, D
Channel catfish	*Ictalurus punctatus*	A, B, C, D, E
Flathead catfish	*Pylodictis olivaris*	C, D, E
Slender madtom	*Noturus exilis*	A, B, C, D, E
Ozark cavefish	*Amblyopsis rosae*	B, C
Northern studfish	*Fundulus catenatus*	A, B, C, D, E
Blackstripe topminnow	*Fundulus notatus*	A, B, D, E
Plains topminnow	*Fundulus sciadicus*	D
Western mosquitofish	*Gambusia affinis*	A, B, D, E
Brook silverside	*Labidesthes sicculus*	A, B, C, D, E
White bass	*Morone chrysops*	D, E
Rock bass	*Ambloplites rupestris*	A, B, C, D, E
Green sunfish	*Lepomis cyanellus*	A, B, C, D, E
Warmouth	*Lepomis gulosus*	B, C, D
Orangespotted sunfish	*Lepomis humilis*	A
Bluegill	*Lepomis macrochirus*	A, B, C, D, E
Longear sunfish	*Lepomis megalotis*	A, B, C, D, E
Redear sunfish	*Lepomis microlophus*	B, E
Smallmouth bass	*Micropterus dolomieu*	A, B, C, D, E
Spotted bass	*Micropterus punctulatus*	A, B, C, D, E
Largemouth bass	*Micropterus salmoides*	A, B, C, D, E

Common Name	Scientific Name	Period1
White crappie	*Pomoxis annularis*	A, B, C
Black crappie	*Pomoxis nigromaculatus*	C
Fantail darter	*Etheostoma flabellare*	A, B, C, D, E
Johnny darter	*Etheostoma nigrum*	B
Stippled darter	*Etheostoma punctulatum*	A, B, D, E
Orangethroat darter	*Etheostoma spectabile*	A, B, C, D, E
Speckled darter	*Etheostoma stigmaeum*	A, B, C, D, E
Banded darter	*Etheostoma zonale*	A, B, D, E
Logperch	*Percina caprodes*	A, C, D
Channel darter2	*Percina copelandi*	A
Freshwater drum	*Aplodinotus grunniens*	C, D
Banded sculpin	*Cottus carolinae*	A, B, C, D, E

- A = collected prior to 1946, B = collected between 1946 and 1982, C = collected between 1982 and 1990, D = collected between 1990 and 1996, E = collected in 1997 and 1998.

- Indicates species restricted to the Neosho basin (Spring and Elk rivers) in Missouri.

Source: Pflieger (1997), MDC Southwest Region Fisheries Files, J. Goddard and H. Kerns collection notes from 1982, W. Pflieger and P. Wohldman collection notes from 1991, J. Petersen, USGS, personal communication.

Aquatic Invertebrates

Table 15 lists crayfish with ranges including the Elk River basin. Only four of the six species have been documented by collection in the basin. Mussel surveys for basin streams are limited. A survey of mussels in the Elk River basin was conducted by Mark Gordon in the late 1970s (Gordon 1980). Thirty species were collected from the basin. Oesch (1984) indicates many mussels occurred in the basin historically. Table 16 lists mussel and snail species collected in the Elk River basin.

Amphibians and Reptiles

There is a diverse assemblage of amphibians and reptiles found in the Elk River basin. Table 17 lists the amphibians and Table 18 lists the reptiles. These tables also include the known range for each species in the basin.

Species of Conservation Concern

The Elk River Basin contains a unique and diverse flora and fauna that includes four federally endangered species. The endangered species are running buffalo clover (*Trifolium stoloniferum*), peregrine falcon (*Falco peregrinus*), Indiana bat (*Myotis sodalis*), and gray bat (*Myotis grisescens*). The two federally threatened species found in the Elk River basin are the Ozark cavefish (*Amblyopsis rosae*) and bald eagle (*Haliaeetus leucocephalus*).

Fish Stocking

Large numbers of fish have been stocked in private impoundments such as farm ponds throughout the Elk River basin. Stocking records for public waters are maintained by the state and federal agencies responsible for their management. Rainbow trout, brook trout, brown trout, lake trout, and grayling were historically stocked throughout the basin, but with the exception of small springfed stream reaches that support rainbow trout, they were unsuccessful. Excluding private impoundment stocking, the only documented warmwater fish stockings in the basin have been carried out by the Arkansas Game and Fish Commission and Bella Vista Property Owners Association in the lakes at Bella Vista, Arkansas.

Largemouth bass, bluegill, redear sunfish, channel catfish, blue catfish, black crappie, white crappie, and fathead minnows have been stocked in various lakes in Bella Vista. These lakes empty into streams in the Little Sugar Creek sub-basin. Stocking records for the Elk River basin are found in Appendix D.

Angler Survey

The first fishing effort and harvest information available for the Elk River basin is the statewide general creel census compiled by Funk (1969) for the years 1946 through 1958. A wide variety of fish species were reportedly harvested during this time. The fish harvest by number indicated that channel catfish were the most commonly taken closely followed by suckers and green sunfish. Other fish, in order by number harvested, were smallmouth bass, rock bass, freshwater drum, largemouth bass, other sunfish, trout, common carp, crappie, white bass, bullheads, flathead catfish, and buffalo. The most recent survey found that catfish were the most sought-after species, followed by black bass. Using harvest to compare present information to historical information, catfish is still numerically the most commonly harvested fish species, followed by largemouth bass, white bass, smallmouth bass, rock bass, drum, suckers, gar, and trout (Weithman, MDC, pers. comm.).

Fishing Regulations

The Elk River basin in Missouri is managed under Missouri's statewide stream regulations with no special management regulations specifically designated for it. The public waters of the Elk River basin in Arkansas and Oklahoma are managed by their respective state fish and wildlife agencies. The lakes in Bella Vista, Arkansas are privately owned and managed. Restrictions and rules can and do change, so it is best to consult the latest fishing regulations.

Table 15. Crayfish with ranges including the Elk River

Common Name	Scientific Name	Collection
Bristly cave crayfish	*Cambarus setosus*	between 1971-1992
Neosho midget crayfish	*Orconectes macrus*	between 1971-1992
Ringed crayfish	*Orconectes neglectus*	between 1971-1992
Northern crayfish	*Orconectes virilis*	between 1971-1992
Grassland crayfish	*Procambaris gracilis*	No (range includes Elk River basin)
Cave crayfish	*Cambarus aculabrum (found in cave in NW Arkansas)*	No (origin of locality stream may be in McDonald County, MO)

Source: Pflieger (1996).

Table 16. Mussels and snails collected in the Elk River basin in Missouri.

Common Name	Scientific Name[1]	Collection[2]
Midland siltsnail	*Cincinnatia integra*	1980
Chert pebblesnail	*Somatogyrus rosewateri*	1980
Slender walker	*Pomatiopsis lapidaria*	1980
Pyramid elimia	*Elimia potosiensis*	1980
Tadpole physa	*Physella gyrina*	1980
Bugle sprite	*Menetus dilatatus*	1980
Marsh rams-horn	*Helisoma trivolvis*	1980
Creeping ancylid	*Ferrissia rivularis*	1980
Striated fingernail clam	*Sphaerium striatinum*	1980
River peaclam	*Pisidium fallax*	1980
Ridged-beak peaclam	*Pisidium compressum*	1980
Paper pondshell	*Utterbackia imbecillis*	after 1965, 1980
Giant floater	*Pyganodon grandis*	after 1965, 1980
Creeper	*Strophitus undulatus*	after 1965, 1980
Elktoe	*Alasmidonta marginata*	after 1965, 1980
Slippershell	*Alasmidonta viridis*	after 1965, 1980
Flutedshell	*Lasmigonia costata*	after 1965
Pimpleback	*Quadrula pustulosa pustulosa*	after 1965
Wabash pigtoe	*Fusconaia flava*	after 1965
Ozark pigtoe	*Fusconaia ozarkensis*	after 1965
Purple wartyback	*Cyclonaias tuberculata*	after 1965
Ohio pigtoe	*Pleurobema cordatum3*	1980
Round pigtoe	*Pleurobema sintoxia*	after 1965
Mucket	*Actinonaias ligamentina*	after 1965, 1980
Ellipse	*Venustaconcha ellipsiformis4*	1980
Fragile papershell	*Leptodea fragilis*	after 1965
Lilliput	*Toxolasma parvus*	after 1965
Purple Lilliput	*Toxolasma lividus*	after 1965, 1980

Common Name	Scientific Name[1]	Collection[2]
Pondmussel	*Ligumia subrostrata*	after 1965
Neosho mucket	*Lampsilis rafinesqueana*	after 1965
Pocketbook	*Lampsilis cardium*	after 1965
Ozark brokenray	*Lampsilis reeviana brevicula*	after 1965
Asian clam	*Corbicula fluminea*	1998

Sources: Oesch (1984), Cummings and Mayer (1992), and Gordon (1980).

- Scientific names were updated through 1999 based on information provided by Sue Bruenderman, MDC research biologist/Malacologist.

- after 1965 - based on information from Oesch 1984.

- Sue Bruenderman believes this identification may be in error and probably should be *Fusconaia flava.*

- Riusech (1999) through genetic analysis found the mussels in the Elk River basin to be ellipse (Venustaconcha ellipsiformis) rather than bleedingtooth mussels (*Venustaconcha pleasii*).

Table 17. Amphibians found in the Elk River basin

Common Name	Scientific Name	Range
Ringed salamander	*Ambystoma annulatum*	Basinwide
Spotted salamander	*Ambystoma maculatum*	Basinwide
Marbled salamander	*Ambystoma opacum*	Eastern counties of the basin
Smallmouth salamander	*Ambystoma texanum*	Western counties of the basin
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	Basinwide
Central newt	*Notophthalmus viridescens louisianensis*	Basinwide
Longtail salamander	*Eurycea longicauda*	Basinwide
Cave salamander	*Eurycea lucifuga*	Basinwide
Graybelly salamander	*Eurycea multiplicata griseogaster*	Basinwide
Oklahoma salamander	*Eurycea tynerensis*	Basinwide
Ozark zigzag salamander	*Plethodon dorsalis angusticlavius*	Basinwide
Slimy salamander	*Plethodon glutinosus glutinosus*	Basinwide
Grotto salamander	*Typhlotriton spelaeus*	Basinwide
Red River mudpuppy	*Necturus maculosis louisianensis*	Basinwide
Dwarf American toad	*Bufo americanus charlesmithi*	Basinwide
Fowler's toad	*Bufo woodhousei fowleri*	Basinwide
Woodhouse's toad	*Bufo woodhousei woodhousei*	possibly in Newton County
Blanchard's cricket frog	*Acris crepitans blanchardi*	Basinwide
Northern spring peeper	*Hyla crucifer crucifer*	Basinwide
Cope's gray treefrog	*Hyla chrysoscelis*	Basinwide
Western chorus frog	*Pseudacris triseriata*	Basinwide
Great Plains narrowmouth toad	*Gastrophryne olivacea*	Western counties of the basin
Northern crawfish frog	*Rana areolata circulosa*	Western counties of the basin
Bullfrog	*Rana catesbeiana*	Basinwide
Green frog	*Rana clamitans*	Basinwide

Common Name	Scientific Name	Range
Pickerel frog	*Rana palustris*	Basinwide
Southern leopard frog	*Rana sphenocephala*	Basinwide
Wood frog	*Rana sylvatica*	Eastern counties of the basin

Source: Johnson (1987).

Table 18. Reptiles found in the Elk River basin.

Common Name	Scientific Name	Range
Common snapping turtle	*Chelydra serpentina serpentina*	Basinwide
Alligator snapping turtle	*Macroclemys temminckii*	Basinwide
Yellow mud turtle	*Kinosternon flavescens*	Basinwide
Stinkpot	*Sternotherus odoratus*	Basinwide
Western painted turtle	*Chrysemys picta bellii*	Basinwide
Mississippi map turtle	*Graptemys kohnii*	Basinwide
Ouachita map turtle	*Graptemys pseudogeographica ouachitensis*	Basinwide
Missouri River cooter	*Pseudemys concinna metteri*	Basinwide
Three-toed box turtle	*Terrapene carolina triunguis*	Basinwide
Ornate box turtle	*Terrapene ornata ornata*	Basinwide
Red-eared slider	*Trachemys scripta elegans*	Basinwide
Midland smooth softshell	*Trionyx muticus muticus*	Basinwide
Western spiny softshell	*Trionyx spinifer hartwegi*	Basinwide
Eastern collared lizard	*Crotaphytus collaris collaris*	Basinwide
Texas horned lizard	*Phrynosoma cornutum*	Basinwide
Northern fence lizard	*Sceloporus hyacinthinus undulatus*	Basinwide
Southern coal skink	*Eumeces anthracinus pluvialis*	Basinwide
Five-lined skink	*Eumeces fasciatus*	Basinwide
Broadhead skink	*Eumeces laticeps*	Basinwide
Great Plains skink	*Eumeces obsoletus*	Basinwide
Ground skink	*Scincella lateralis*	Basinwide
Prairie-lined racerunner	*Cnemidophorus sexlineatus viridus*	Basinwide
Western slender glass lizard	*Ophisaurus attenuatus attenuatus*	Basinwide
Western worm snake	*Carphophis amoenus vermis*	Basinwide
Eastern yellowbelly racer	*Coluber constrictor flaviventris*	Basinwide
Prairie ringneck snake	*Diadophis punctatus arnyi*	Basinwide

Common Name	Scientific Name	Range
Great Plains rat snake	*Elaphe guttata emoryi*	Basinwide
Black rat snake	*Elaphe obsoleta obsoleta*	Basinwide
Eastern hognose snake	*Heterodon platyrhinos*	Basinwide
Prairie kingsnake	*Lampropeltis calligaster calligaster*	Basinwide
Speckled kingsnake	*Lampropeltis getulus holbrooki*	Basinwide
Red milk snake	*Lampropeltis triangulum syspila*	Basinwide
Eastern coachwhip	*Masticophis flagellum flagellum*	Basinwide
Blotched water snake	*Nerodia erythrogaster transversa*	Basinwide
Diamondback water snake	*Nerodia rhombifer rhombifer*	Basinwide
Midland water snake	*Nerodia sipedon pleuralis*	Basinwide
Rough green snake	*Opheodrys aestivus*	Basinwide
Bullsnake	*Pituophis melanoleucas sayi*	Basinwide
Graham's crayfish snake	*Regina grahamii*	Western counties of the basin
Ground snake	*Sonora semiannulata*	Basinwide
Midland brown snake	*Storeria dekayi wrightorum*	Eastern counties of the basin
Texas brown snake	*Storeria dekayi texana*	Basinwide
Northern redbelly snake	*Storeria occipitomaculata occipitomaculata*	Basinwide
Flathead snake	*Tantilla gracilis*	Basinwide
Western ribbon snake	*Thamnophis proximus proximus*	Basinwide
Eastern garter snake	*Thamnophis sirtalis sirtalis*	Basinwide
Red-sided garter snake	*Thamnophis sirtalis parietalis*	Western counties of the basin
Central lined snake	*Tropidoclonion annectens lineatum*	Newton County
Rough earth snake	*Virginia striatula*	Basinwide
Western earth snake	*Virginia valeriae elegans*	Basinwide
Osage copperhead	*Agkistrodon phaeogaster contortrix*	Northwest counties of the basin
Southern copperhead	*Agkistrodon contortrix contortrix*	Basinwide

Western cottonmouth	*Agkistrodon piscivorus*	Basinwide
Timber rattlesnake	*Crotalus horridus*	Basinwide
Western pygmy rattlesnake	*Sistrurus miliarius streckeri*	Southern counties of the basin

Source: Johnson (1987).

Management Problems and Opportunities

The Missouri Department of Conservation (MDC) is charged with the '…control, management, restoration, conservation and regulation of the bird, fish, game, forestry and all wildlife resources of the state...' As stated in MDC's recent Regional Management Guideline documents, 'The Conservation vision is to have healthy, sustainable plant and animal communities throughout the state of Missouri for future generations to use and enjoy, and that fish, forest, and wildlife resources are in appreciably better condition tomorrow than they are today.' In order to achieve this vision, efforts to better manage streams and their watersheds will be a continuing priority in the Elk River watershed.

This section includes strategic guidelines to provide MDC Fisheries Division staff working in the watershed with management direction to address the issues detailed in earlier sections. These issues include point and nonpoint source pollution, increasing urbanization, loss of riparian vegetation, the effects of large confined animal operations, mining influences, dam and hydropower influences, instream flow issues, increasing demands for recreation, and threats to aquatic life within the watershed. The guidelines will be used to address future stream management, public awareness, and public access issues and needs.

Goal I: Improve water quality and maintain or improve water quantity in the Elk River Watershed so all streams are capable of supporting high quality aquatic communities.

Objective I.1: Streams within the watershed will meet state standards for water quality.

Guidelines:

- Enhance people's awareness of 1) water quality problems (i.e., point source pollution, animal waste runoff, etc.) affecting aquatic biota, 2) viable solutions to these problems, and 3) their role in implementing these solutions.
- Review NPDES, Section 404, and other permits and either recommend denial or appropriate mitigation for those which are harmful to aquatic resources, and investigate pollution events and fish kills.
- Work with the Missouri Department of Health and MDNR to monitor and reduce contaminant levels in fish.
- Work with MDNR to monitor water quality, improve water quality, and ensure compliance with discharge
- permits.
- Serve in an advisory role to citizen organizations and local governments on water resource issues.

Objective I.2: Maintain base flows in streams within the watershed at or above current levels within the constraints imposed by natural seasonal variations and precipitation.

Guidelines:

- Establish flow regimes that protect or enhance fish and other aquatic life.
- Working with MDNR and USCOE, protect or enhance stream flows through oversight and enforcement of existing water withdrawal permits and other related permits.
- Support development of water law and an interstate compact/agreement that will address the quantity of water in Missouri's streams.
- Increase public awareness of and concern for water quantity problems, the affected aquatic biota, and potential solutions.

Goal II: Improve riparian and aquatic habitat conditions in the Elk River watershed to meet the needs of aquatic species while accommodating demands for water and agricultural production.

Objective II.1: Riparian landowners will understand the importance of good stream stewardship and where to obtain technical assistance for sound stream habitat improvement.

Guidelines:

- Work with MDC's Outreach and Education Division staff to develop stream management related materials and present related courses for elementary and secondary school teachers.
- Establish and maintain stream management demonstration sites.
- Promote good stream stewardship through landowner workshops and stream demonstration site tours.

Objective II.2: Maintain, expand, and restore riparian corridors; enhance watershed management; improve instream habitat; and reduce streambank erosion throughout the watershed.

Guidelines:

- Periodically monitor and assess habitat and riparian area conditions on selected streams in the watershed.
- Ensure that all MDC areas are examples of good stream and watershed management.
- Provide technical recommendations to all landowners that request assistance.
- Improve riparian corridor and watershed conditions by actively cooperating with other agencies on watershed based projects.
- Improve landowner stewardship of streams by promoting and implementing cost share programs, including MDC's watershed based programs, that include streambank stabilization, alternative watering provisions, and establishment and maintenance of quality riparian corridors.

Objective II.3: Critical and unique aquatic habitats will be identified and protected from degradation.

Guidelines:

- Conduct additional fish population sampling to further define and delineate unique and critical habitats.
- Collect additional background information from the public and resource professionals to better define critical and unique aquatic habitats.
- Acquire, protect, and enhance critical and unique aquatic habitats.

Goal III: Maintain diverse and abundant populations of aquatic organisms while accommodating angler demands for quality fishing.

Objective III.1: Evaluate and maintain sportfish populations and maintain sufficient quality and condition of these populations to satisfy the angling public.

Guidelines:

- Develop and implement a monitoring program to obtain trend data on sportfish populations and angler use of these populations in selected stream reaches.
- Identify critical habitat areas for sportfish species and maintain or enhance these areas as needed to improve habitat.
- Using regulations, habitat improvement, and other methods, continue implementation of population improvement programs for sportfish species.
- Increase angler awareness of the recreational potential of fishes such as catfish, buffalo, carp, drum, and gar.

Objective III.2: Maintain populations of native nongame fishes, including the Ozark cavefish, and aquatic invertebrates at or above present levels throughout the watershed.

Guidelines:

- Develop standard sampling techniques for assessing fish and invertebrate communities, including the use of indicator species. Implement a monitoring program to track trends in species diversity and abundance.
- Maintain or enhance aquatic biodiversity and abundance using regulations, stocking, habitat improvement, and related techniques,
- Continue public awareness and habitat management efforts related to aquatic species of special concern. Consider additional possibilities for non-MDC funding for additional inventory work, continued public awareness efforts, and habitat management efforts.
- Protect and improve habitats that support populations of aquatic species of special concern by implementing MDC cost share programs and encouraging cost share practices that protect and enhance streams, riparian areas, sinkholes, caves, and springs to be included on NRCS/SWCD dockets.
- Participate in species recovery efforts including interstate conferences and recovery team meetings.

Goal IV: Improve the public's appreciation for stream resources and increase recreational use of streams in the Elk River watershed.

Objective IV.1: Access sites, bank fishing areas, and trails will be developed and maintained in sufficient numbers to accommodate public use.

Guidelines:

- Conduct a recreational use survey within the watershed in conjunction with an angler survey to determine existing levels of use and satisfaction with recreational opportunities in the watershed.

- Acquire and develop appropriate public access and frontage sites.
- Improve bank fishing and other aquatic wildlife based recreational opportunities on public lands.

Objective IV.2: Increase the general public's awareness of stream recreational opportunities, local stream resources, and good watershed and stream management practices.

Guidelines:

- Working with MDC's Outreach and Education Division staff, use streams in aquatic education programs. Identify and develop stream locations appropriate for educational field trips near participating schools.
- Maintain a stream emphasis at public events such as the Ozark Empire Fair, Springfield Boat Show, etc.
- Assist in the development of articles, videos, etc. that highlight Elk River watershed recreational opportunities.
- Prepare an annual fishing prospectus for selected streams.
- Promote the formation of STREAM TEAMs and STREAM TEAM associations within the watershed.
- Distribute information through STREAM TEAMs and related organizations.

Angler Guide

Elk River (Southwest Region)

Elk River is very popular with canoeists in southwest Missouri. The river also provides numerous fishing opportunities. All three species of **black bass** are present. **Smallmouth bass** are numerous and are usually found where good cover (rootwads and boulders) and current meet. Some of the better smallmouth bass habitat can be found between Pineville and MDC's Mt. Shira Access. During recent electrofishing surveys smallmouth bass up to 16" were collected. Excellent opportunities are also available to catch rock bass (goggle-eye). Fishing small, floating crayfish colored crankbaits, plastic jigs or live bait (crayfish and worms) around woody cover or large boulders in flowing water should provide the best results. **Channel catfish** are common in the lower sections of the river. Catfish can be caught on a variety of natural and prepared baits. If you enjoy gigging, the Elk River should not be overlooked. Clear water and an abundance of **redhorse suckers** and **northern hogsuckers** should provide for plenty of action. Public access sites are available on the upper river at MDC's Mt. Shira Access and on the lower river at Cowskin Access. Numerous canoe rental businesses are also located nearby, with drop-off and pick-up sites at several locations along the river.

Glossary

Alluvial soil - soil deposits resulting directly or indirectly from the sediment transport of streams, deposited in river beds, floodplains, and lakes.

Aquifer - an underground layer of porous, water-bearing rock, gravel, or sand.

Benthic - bottom-dwelling; describes organisms which reside in or on any substrate.

Benthic macro-invertebrate - bottom-dwelling (benthic) animals without backbones (invertebrate) that are visible with the naked eye (macro).

Biota - the animal and plant life of a region.

Biocriteria monitoring - the use of organisms to assess or monitor environmental conditions.

CAFO - (Concentrated Animal Feeding Operation) due to semantics, differentiating between small scale, medium sized, and large feeding operations was difficult so all concentrated animal feeding operations in this document are referred to as animal feeding operations.

Chert - hard sedimentary rock composed of micro-crystalline quartz, usually light in color, common in the Springfield Plateau in gravel deposits. Resistance to chemical decay enables it to survive rough treatment from streams and other erosive forces.

cfs - Cubic feet per second.

Disjunct - separated or disjointed populations of organisms. Populations are said to be disjunct when they are geographically isolated from their main range.

Dissolved oxygen - the concentration of oxygen dissolved in water, expressed in milligrams per liter or as a percentage.

Endangered - in danger of becoming extinct.

Endemic - found only in, or limited to, a particular geographic region or locality.

EPA - **E**nvironmental **P**rotection **A**gency.

Epilimnion - the upper layer of water in a lake that is characterized by a temperature gradient of less than 1^{o} Celsius per meter of depth.

Eutrophication - the nutrient (nitrogen and phosphorus) enrichment of an aquatic ecosystem that promotes biological productivity.

Extirpated - exterminated on a local, political, or geographic portion of the range.

Fecal coliform - a type of bacterium occurring in the guts of mammals. The degree of its presence in a lake or stream is used as an index of contamination from human or livestock sewage.

Flow duration curve - a graphic representation of the number of times given quantities of flow are equaled or exceeded during a certain period of record.

Fragipans - a natural subsurface soil horizon seemingly cemented when dry, but when moist showing moderate to weak brittleness, usually low in organic matter, and very slow to permeate water.

Gauge station - the site on a stream or lake where hydrologic data is collected.

Gradient plot - a graph representing the gradient of a specified reach of stream. Elevation is represented on the Y-axis and length of channel is represented on the X - axis.

Hydro-peaking - rapid and frequent fluctuations in flow resulting from power generation by hydroelectric dams to meet peak electrical demands.

Hydrologic unit - a subdivision of a watershed into smaller areas, generally 50,000 acres or less.

HUC - Hydrologic Unit.

Hypolimnion - the region of a body of water that extends from the thermocline to the bottom and is essentially isolated from major surface influences.

Intermittent stream - one that has intervals of flow interspersed with intervals of no flow. A stream that ceases to flow for a time.

Karst topography - an area of soluble bedrock formations marked by sinkholes, caves, springs, and underground streams.

Loess - loamy soils deposited by wind, often quite erodible.

Low flow - the lowest discharge recorded over a specified period of time.

MDC - **M**issouri **D**epartment of **C**onservation.

MDNR - **M**issouri **D**epartment of **N**atural **R**esources.

Mean monthly flow - arithmetic mean of the individual daily mean discharge of a stream for a given month.

MSL - **M**ean **S**ea **L**evel.

Necktonic - organisms that live in open water areas (mid and upper) of waterbodies and streams.

Non-point source - source of pollution in which wastes are not released at one specific, identifiable point, but from numerous points that are spread out and difficult to identify and control.

NPDES - **N**ational **P**ollution **D**ischarge **E**limination **S**ystem.

Nutrification - increased inputs, viewed as a pollutant, such as phosphorus or nitrogen, that fuel abnormally high organic growth in aquatic systems.

Optimal flow - flow regime designed to maximize fishery potential.

Perennial streams - streams fed continuously by a shallow water table.

pH - numeric value that describes the intensity of the acid or basic (alkaline) condition of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).

Point source - source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.

Recurrence interval - the inverse probability that a certain flow will occur. It represents a mean time interval based on the distribution of flows over a period of record. A 2-year recurrence interval means that the flow event is expected, on average, once every two years.

Residuum - unconsolidated and partially weathered mineral materials accumulated by disintegration of consolidated rock in place.

Riparian - pertaining to, situated, or dwelling on the margin of a river or other body of water.

Riparian corridor-the parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.

7-day Q^{10} - lowest 7-day flow that occurs on average once every ten years.

7-day Q^{2} - lowest 7-day flow that occurs on average once every two years.

SALT - **S**pecial **A**rea **L**and **T**reatment project.

SHAD - **S**tream **H**abitat **A**nnotation **D**evice.

Stream gradient - the change of a stream in vertical elevation per unit of horizontal distance.

Stream order - a hierarchical ordering of streams based on the degree of branching. A first order stream is an unbranched or unforked stream. Two first order streams flow together to make a second order stream; two second order streams combine to make a third order stream, and so on. Stream order is often

determined from 7.5 minute topographic maps.

Solum - the upper and most weathered portion of the soil profile.

Substrate - the mineral and/or organic material forming the bottom material of a waterway or waterbody.

Thermocline - the plane or surface of maximum rate of decrease of temperature with respect to depth in a waterbody.

Threatened - a species likely to become endangered within the foreseeable future if certain conditions continue to deteriorate.

USACOE - United States Army Corps of Engineers- responsible for certain regulation of water courses, some dams, and flood control projects.

USGS - United States Geological Survey.

Watershed - the total land area that water runs over or under when draining to a stream, river, pond, or lake.

WWTF - **W**aste **W**ater **T**reatment **F**acility.

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